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January 17, 1929

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Engineering News-Record

Devoted to Civil Engineering and Contracting

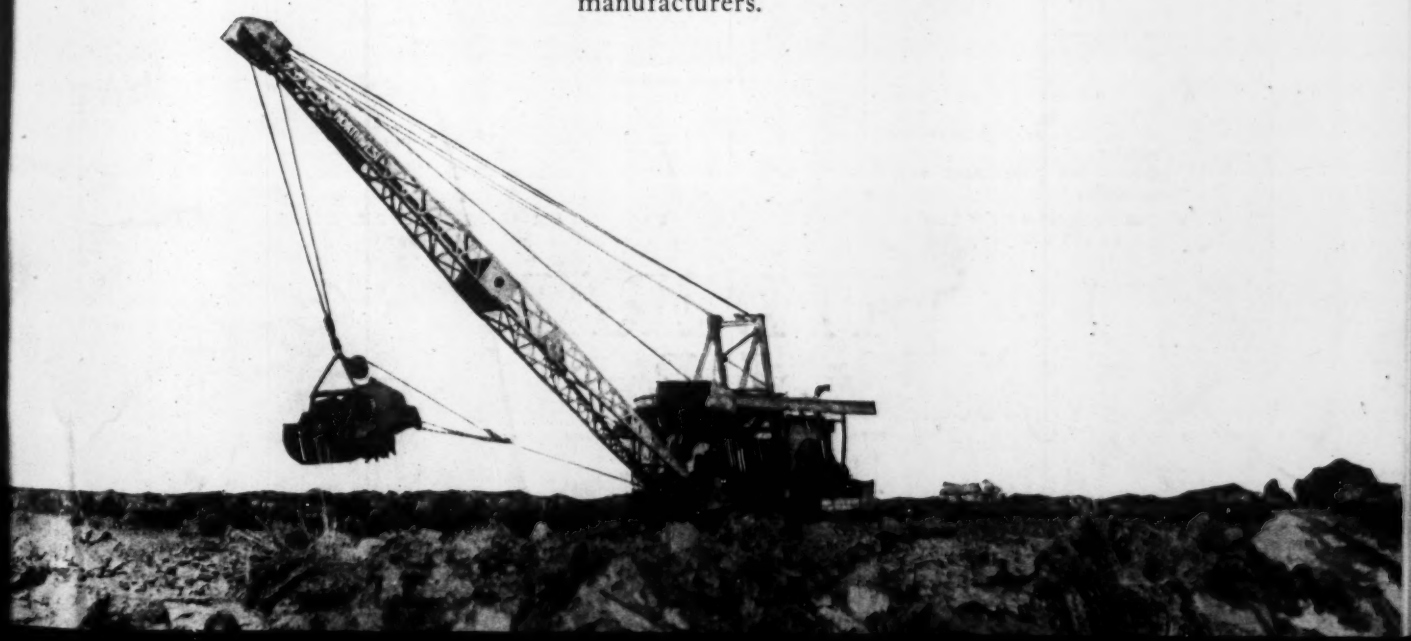
Construction Tasks on the Mississippi

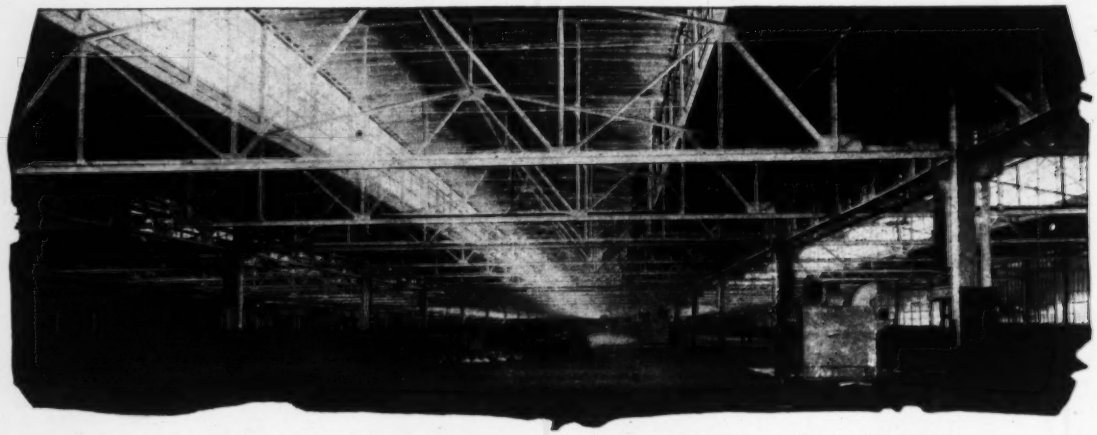
FLOOD CONTROL WORK on the Mississippi will cost $325,000,000 in the next ten years. Over $300,000,000, or $30,000,000 a year, will be spent for engineering construction—levees, revetments, wing dams and spillways.

A survey of construction conditions of this enterprise has just been made by Charles S. Hill, associate editor, in an extended tour along the Mississippi. He reports his findings in a series of three articles, the first of which appears in this issue:

I—Volume of Work and Construction Conditions.
II—Levee Construction Methods and Plant.
III—Revetment Construction Plant and Methods.

Mr. Hill's survey presents an appraisal of the construction task and outlines the demands which the work imposes on contractors and equipment manufacturers.





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THAT widely known concrete authority Nathan C. Johnson estimates an annual expenditure of two billions of dollars for concrete construction. Just how efficiently this vast sum is being spent has come to be a burning question.

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Difficulties of Standardization

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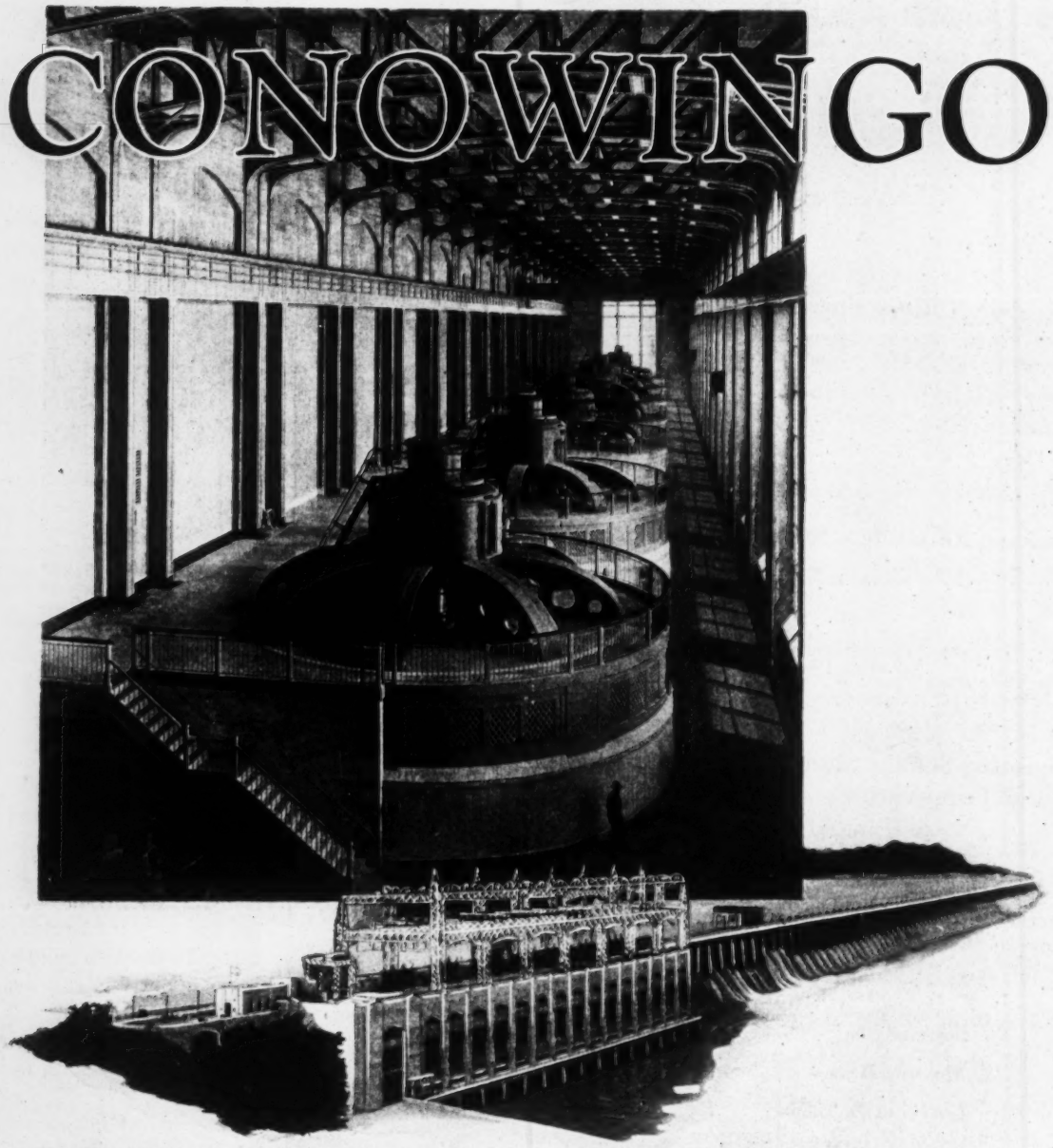

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Volume 102 NEW YORK, JANUARY 17, 1929 Number 3

Without Legal Basis

AS WE go to press news comes that the Supreme Court of the United States in a sweeping decision declares illegal the abstraction of Great Lakes waters by the Sanitary District of Chicago for sewage flushing. A long-drawn-out case is thus brought to a close at last. "Merely to aid the District in disposing of its sewage was not a justification" for a permit to draw more water than was required as an aid to navigation, says the Court. After severely rebuking the Sanitary District for defying the authority of the national government, it proceeds to state that the District "can not now complain if an immediately heavy burden" is placed upon it. As the decision is of fundamental importance as regards the diversion and use of interstate waters we hope to present it in liberal abstract next week. But even its bare outline makes evident that the District is confronted, quite immediately, by a task of most formidable proportions; straightening out its financial position and going ahead with utmost expedition in thorough and complete sanitation of its sewage to meet the necessity of lessening lake diversion in accordance with the mandate.

Turbine Refinement

REFINEMENTS in hydraulic turbines and settings to add a few fractional points to their efficiency have become common in the last few years. More recently, attempts to widen the range through which their output will approach a condition of maximum efficiency under varying operating conditions have resulted in the adoption of propeller-type turbine runners with movable blades. Such runners have been in use for some time now, particularly in Europe. The most notable example in this country is in the Chippewa Falls plant of the Northern States Power Company, which is described in this issue. In some of the European plants mechanism to control the angle of the blade from the governor of the turbine is employed, but it is complicated and has not been adopted for the Chippewa plant. There, the change is made manually, the unit being shut down for a short period for that purpose. The Chippewa plant's unusual situation warrants the added cost of the adoption and use of movable blades. It stands a few miles down the stream from a larger plant, and has no pond of its own from which to draw, or in which to hold back water. Consequently it must use water as it comes to it, and in such quantities as comes from the upper plant. By being able to adjust the runner blades their efficiencies are kept high over a much wider range than would be possible without such a mechanical refinement.

Over the Cascades

MAN'S third conquest by rail of a pass over the Cascade Range is completed. Forty years ago John F. Stevens discovered the pass which now bears his name, and shortly thereafter the first rail line of the Great Northern, a switchback line, was built. It was realized then that the summit could be cut down by tunnels of various lengths when operating conditions warranted the greater expenditures. In 1900 the first of such tunnels was built, a short one 2.63 miles long to eliminate the switchback. It improved the line greatly but involved the continued use of much sharp curvature, heavy grades and many snowsheds. Now the third line has been completed, cutting down the summit 502 ft., saving nearly 9 miles in distance and eliminating the long, dangerous snowsheds of the old line and much of its curvature. The outstanding feature of this line is is the 7.79-mile tunnel, which was completed in three years from the date of the start of work. The progress made on this tunnel stands out in sharp contrast to that of the early days of railroad tunneling, when the work was carried on from single faces at each end upon which only a limited number of men could work. In this new tunnel, at one time, eleven faces were being worked and 1,800 men were employed. This was made possible by the use of a pioneer tunnel and an intermediate shaft. The tunnel stands as a monument to the skill and executive ability of the engineers and contractors who built it and to the men who perfected the tools and equipment with which they worked. It was fitting indeed that such men as Ralph Budd, W. W. Atterbury and Herbert Hoover paid tribute to the achievement in country-wide radio broadcast last Saturday.

A Necessary First Step

TWO concrete structures built a few years ago under similar conditions were recently examined. Both had been built by experinced engineers and capable contractors, under approved specifications. Yet one of them now looks clean and new, while the other has a decaying surface. Why? An answer has not been found, but we believe the question is as serious as any now before the engineering world. It might be thought that the one contractor was less skilled than the other. But some miles away there is a third structure, involving only one contractor and one set of workmen, which shows parts that are going to pieces and other parts that have remained sound; it is hard to believe that this contractor was competent at one moment and incompetent at another. Something else must have been at fault. We happen to know personally that in all three cases the engineers had inspected the work and found it to comply with their specifications. If, then, a specification carried out with at least average skill and faithfulness does not assure the expected results, we are forced to ask whether the specification does in fact specify effectively. Puzzles of the kind presented by the three structures mentioned are neither new nor rare, but lately they have been getting insistently obtrusive. If they continue, what of the future? The past year or two seems to have done little toward their solution. The current year ought to do better. It should at least see a determined attack on the problem—its difficulties analyzed and discussed without

reserve. In this spirit we expect to publish next week a noteworthy critique of the situation, having the essential purpose of stirring up active thought on concrete-making. Such thought will mean at least that the problem is recognized—the first step toward its solution.

Advancing Craftsmanship

DEVELOPMENT of skill in the technique of the crafts of construction is as active a factor of progress nowadays as in earlier ages, despite a common tendency to believe that modern advances are made wholly through inventive creation of new methods and tools. An excellent illustration is presented in the current issue by a statement of the operative procedures worked out for applying the cement gun to the production of closely controlled geometrical forms. There is much ingenuity and corresponding perfection of working skill in these procedures, and it will also be seen that the character of the work produced represents a measurable extension of the powers of the concrete art. Many structural parts with plane surfaces and straight edges can be shaped, and perhaps by some modification also parts with curved exterior. This means the possibility of competing with formed and poured concrete in such work as has small volume per unit of surface area, a competition which promises to be both economically and technically advantageous to concrete construction. Not only does the development instance well the contribution of improved detail skill to the art of building with concrete but it has even broader significance in demonstrating the continuing influence of growth in skill of performance upon modern progress.

Measured in Money

LAST week, in remarking on the noise nuisance, we said that noise has not yet come to have a dollars-and-cents meaning. But it appears that such a meaning may be on the point of evolving. A street-railway company announces that it is engaged in rebuilding a number of its cars with quieter gearing and wheels, evidently in order to reduce the irritating roar and the grind of the street car rather than to save power or repairs. The street car, in other words, is to be made more attractive—or less objectionable—to its patrons. As every one knows it is engaged in sharp competition with the motor bus, and this newcomer in the transportation field has made surprising progress over its old-established rival. People prefer the bus, even at higher cost, and in all probability its smooth quietness of operation is a factor in creating this preference. If, as has often been noticed, residents along a heavy-traffic bus line are subject to less annoyance than those along a street-car line of lighter service, it is not hard to see how a favorable psychology toward the bus may grow up. In other words, relative noiselessness takes on a certain money value, and we thus approach the point where undesirability of noise can be measured in money. A year ago we had occasion to refer to a related effect, in speaking of the popular interest in fusion welding for steel building frames in cities, based on the distracting noise of the pneumatic riveting hammer. Some recent cases in which redress was sought against contractors for operating pilehammers or concrete-mixing plants far into the night give evidence of the same trend of sentiment. If there is such progress toward placing a definite money charge against noise, prospects for ultimate noise control are not without hope.

An Industry Called to Action

DOWN along the Mississippi the stage is set for new performances. Construction work is to be done to the tune of twenty to thirty millions of dollars a year in carrying out the official flood-control project. But big as these sums are, it is not so much the magnitude as the character of the work that defines the task. Operations quite new to the Mississippi are to be executed, and the large issues involved make it imperative that they be done efficiently and rapidly, which means by thoroughly planned, high-production methods. To devise these methods and prepare for applying them is the great task of the construction industry—contractors and plant builders alike.

It is many years since combined opportunity and obligation have confronted the industry in such a way. Thirty-five years ago the Chicago Drainage Canal presented a similar problem; perhaps, considering the changed scale of things, it was equally great. Yet the factor of speed was less compelling there, and if several years of evolution were required before the new tools and new ways of conducting the excavation of that great channel prism attained reasonable efficiency, the loss of time was not a critical matter. Today no such delays can be contemplated. The very nature of the task which the Mississippi work presents forbids leisurely experimentation.

Those who are to provide the machines and the constructing ability must be ready for their part from the beginning. There is too much at stake to permit anything else. At tremendous cost the nation has undertaken the responsibility for protecting the valley, and the execution of the official plan, be it right or wrong, must be attacked promptly and vigorously.

The work is new. Levee-building requirements are fundamentally different from those heretofore prevailing. Except on the floodway levees, perhaps, the time-honored procedure of scooping up earth from a convenient near-by borrowpit and throwing it over into the embankment is out of the picture. Material must be brought from a distance—half a mile away, or miles away, according to the conditions of the individual location. The old levee-building machinery is helpless in the face of this demand. Deposition and compacting also are likely to offer new requirements, if the broader and safer levees contemplated in the project are to be in fact more dependable than the random heaps of earth that often had to suffice in the past.

So far the Mississippi River Commission, which is charged with the direction of the work, has not found time to do much toward laying before the contracting and equipment industries the peculiar requirements of the task they will soon be called upon to perform. What kind of material is to be handled, where it can be obtained, how far it must be hauled, to what extent it must be sorted, mixed and compacted, and where and how it shall be placed with respect to the existing levee mass—these matters remain unknown. Knowledge of each and all of them is essential.

To confirm the belief that it is indeed a new type of work which awaits contractors along the Mississippi, and to define the nature of this task as clearly as may be, a staff representative of *Engineering News-Record* made a tour of inspection down the river and recorded his observations. His general outline, published on another page, is to be followed by articles dealing more specifically with levees and revetment. It should be remembered that the working season and the fiscal year

governing appropriations and contracts do not coincide, so that it is the fiscal year beginning next July which is to see the real beginning of major construction. Accordingly there are several months of preparation time for planning machinery and methods; but in view of the nature of the problem this is a very short time.

As already indicated, the problem of building the great new levees is distinguished by two major features: first, each locality will present different governing conditions, not only as to kinds of material and the handling of labor but also as to exposure to interruption by river stages; and second, the work involves huge quantities and long distances, and therefore will almost inevitably have to be handled on large-scale basis. It is no cellar excavator's job but a great co-ordinated enterprise which requires to be laid out in sections of such size that efficient and systematized procedure can be developed.

As to the difference of conditions in different sections, it is easy to see that bidders will need time to study the local conditions and search out the most effective methods. This being so, it appears vital that bids be invited at an early stage, so as to give unusually ample margin of time before the bidding date. The officials in charge have made no statements as to what length of time will be allowed for preparing bids, but it may be taken for granted that they are keenly aware of the need for adequate preparation.

At the best that may be expected, however, contractors within a very few months will be asked to take up their share in the Mississippi River work—to do the work quickly, excellently and cheaply. It is their task, and that of the skilled developers of construction machinery, to be ready for the call.

Continuous Structures

STRUCTURAL views have made distinct progress since the days when continuous bridges were considered bad practice. A new continuous bridge of large size has just been completed over the Missouri, and erection is just beginning on a continuous structure across Lake Champlain. These instances reflect the fact that engineers have quite generally come to accept the type as the full equivalent of other types where conditions are such as to make it adapted to the field requirements of erection and where it is economical in material.

This change from the prevailing attitude of a quarter-century ago is the resultant of several factors. Apprehension concerning the initial adjustment, the effect of settlement and the uncertainty of analysis have been overcome by more thorough grasp of structural relations and by increased constructive skill. It has been found to be a simple matter to assure correct initial conditions, for example, by setting up the desired reactions at the supports through hydraulic jacks. The proper economies of constrained types of structure are better appreciated, and this in turn has been helped along not only by practice but also by the increased recognition given to rigidity in service.

Further, the popularizing of mechanical stress analysis for use where direct calculation is too complicated for practical design has been of double assistance. Not only has it cleared away an obstacle to correct proportioning but it supplies an eye-picture of deformations and thereby helps to create a better conception of how movements at supports or abutments may influence stresses.

Besides these general factors of changed attitude, there is a special one relating to steel bridge truss construction. During the dominance of pin connections, forty years and more ago, stress reversal was necessarily undesirable. Because of the effect of pin-hole play, adjustable members drawn up to initial tensions of unknown amount had to be used wherever reversal might occur, and the uncertainties of such an arrangement opposed its use in major members. Accordingly the continuous type, with its reversals of stress, was in disfavor and in fact the cantilever bridge type was evolved in the effort to realize most of the advantages of continous construction and yet avoid reversal. Later, when riveted connection displaced pin connection, the former prejudice was no longer in place; yet as an esablished tradition it maintained its force upon engineering opinion.

Steel design still shows a leaning to simple (or, as they are usually called, statically determined) forms of structure, while concrete construction by its very nature turned toward constrained forms at an early stage. If steel roof construction still adheres to simple-span purlins, or if rigid-frame design as applied in the Westchester County park bridges still finds little following in the steel field, it must be charged in large part to this survival. With the progressive weakening of what remains of the old influence and with the growing number of continuous bridges as a constructive precedent, we may look forward to more rapid extension of continous structures.

Labor's Part in Industry

CONTRASTING the attitude of German industrialists toward labor with that of those in America, Dr. Klein, of the Department of Commerce, recently touched upon one of the fundamental reasons why the application of American methods to German industrial life has not been so successful as might have been expected from results in this country. As an example he cited the case of a German banker who, after observing all the labor-saving devices in use in one of our great banks, went home and installed similar devices in his bank, thereby being able to accomplish with one man what it had previously required several men to do. When asked what increase in wages the one man received under the new plan, the banker replied that he had received no increase, that he really had easier work and that it was neither his initiative nor his capital that was responsible for the change. Therein, said Dr. Klein, lies much of the reason for labor's discontent with the new order in Germany.

The banker's case was no exception. Many industries, after studying American methods, have turned to labor-saving machines to cut down their labor cost. Superficially the banker's argument appears sound, but actually labor has had an important part because frequently it has been the initiative of the laborer which has stimulated and developed the present-day machine. This fact has been realized in this country and as a result part of the profit from the substitution of machines for hand labor is being passed on to the fewer operatives required. Higher wages have increased the demand for luxuries and greater comforts and so have built up new industries which have absorbed the labor released by the greater mechanization of the older ones. The result, as Dr. Klein pointed out, is signalized by the general contentment in this country and the unrest of labor in Germany.

Without doubt there is a direct relation between higher standards of living in America and the willingness of American labor to accept labor-saving machinery. It lies in labor's knowledge that it will profit by the economies made.

Mississippi River Flood Control

I—Volume of Work and Construction Conditions

Allocation of Expenditures by Years and Classes of Work—Contracting Opportunities—Organization for Construction Control—Conditions Governing Levee Construction—What Should the Contractor Do?

By C. S. Hill
Associate Editor, Engineering News-Record

MISSISSIPPI RIVER flood control as now planned is a ten-year task. During this year and in 1930 the work all along the river will take on the aspect of a testing laboratory for determining future construction practice. The structures which are produced in conducting experiments will be permanent and integral parts of the final river improvement, but they will be the products of trial methods undertaken to determine those that are practicable and to appraise their value. Old methods will be analyzed, but chiefly the study will be to discover new combinations and devices that will cheapen and increase output. In this there is great opportunity for contractors and equipment men.

Mississippi River flood control throws out a challenge to the construction industry. A third of a billion dollars is to be expended in ten years for levees, bank revetment, contraction works, dredging and construction plant and engineering surveys. In what yearly amounts will the money be spent and under whose control and direction? What kinds of construction are planned and what proportion of the total cost will each represent? What conditions will influence planning, planting, and construction methods? To what extent will the market be open to contracting and to the invention of the equipment manufacturers and the materials producer? To learn the answer to these questions Mr. Hill lived for three weeks with the engineers on the current construction operations. The present article reports his findings.

The old practices are not adequate. In the present improvement program the yearly volume of construction is much greater than it has been previously. The levee sections are heavier and call for increased borrow. Much of the work is enlargement where the old levees have consumed adjacent material, and the builder must go farther afield for his borrow and concentrate harder on the transportation element of earth moving. This fact must be fixed in mind.

Introduction of long haul into levee construction, with the possibilities of wider selection of material and consequent encouragement of higher requirements of embankment workmanship, is the outstanding new and difficult factor in the present and future levee earth-moving problem. Finally, resuming the count, revetment construction is changing from willow mats to concrete, which requires an entire change in design, equipment and construction thinking.

These factors in the new construction problem will be developed further as the discussion proceeds, but their bare statement here is sufficient indication that old practices must be improved and new practices developed. It is important for contractors and equipment manufacturers to get this fact firmly in mind. As merchandisers of construction service they cannot meet requirements with stock from the shelves—different and better machines and methods must be put in stock.

It should perhaps be explained that the operations considered in the discussion that follows are limited to the river-control structures proper. The incidental operations in the floodways—changing and raising highway and railway routes and grades, with various other reconstruction tasks involved in the flood-control plan—are not considered. In the aggregate the cost of these subsidiary tasks will run into many millions and will merit consideration. At present they are in the surveying and planning stage and little or no construction has been done.

Volume of Construction

How much work will there be?

In detail how much work there will be, where it will be located, and in how many jobs it will be let, are now undetermined. Indeed it can be stated only as each year's studies develop and plans for work which is yet to be undertaken can be worked out in detail. The contractor who wishes to know today precisely where the construction for future years will be, and how large the jobs are, cannot be told. The plans of the district engineers have to be made up each year and have to go for revision and recommendation to the president of the Mississippi River Commission and then for confirmation to the Chief of Engineers. Only then are the allocation and amount of work definite. So it will be for each year until the total $325,000,000 is consumed. There is this prospect, however, that as the engineers get farther into the work continuing contracts can be developed and work foretold farther ahead.

Classification of Work—As provided in the adopted plan, the construction work comprises (1) levee construction, which is greatly the largest item; (2) revetment construction and contraction works; and (3) the Bonnet Carré spillway. In addition, the improvement operations as a whole include dredging for channel maintenance; surveys and gagings; new plant, plant replacements and plant upkeep; and right-of-way acquirement. The cost total further involves overhead and reserve funds.

Prospective Yearly Expenditures—In appraising prospective construction it must be kept in mind that all amounts are in round figures and are estimates based on what is visible ahead. On the basis of $325,000,000 available from 1929 to 1938, inclusive, the plan is to spend some $24,000,000 in 1929 and $30,000,000 in 1930. Then for four years the amount will be $40,000,000 a year, including the year 1934. Expenditures will then

decrease to $35,000,000 a year for 1935 and 1936 and to $25,000,000 a year for 1937 and 1938. These are total amounts for both groups of expenditures previously defined. It is possible to break them down into approximate percentages, but with ten years of work ahead even approximations must be guarded by qualification. It should be explained that the years named are fiscal years —July 1 to June 30.

As 1929 is the year of getting under way, there will be a heavy plant expenditure, about 15 per cent of the total. This year, too, the Bonnet Carré spillway will be started, at a cost of about 6 per cent of the total. Then there will be spent about 37 per cent for levees and 33 per cent for revetment and contraction works. In the following years levee work will amount to from a little less than half to a little more than half of all the appropriation, and revetment and contraction works will keep at about one-eighth of the appropriation, increasing each year. Considering only the peak years (1931 to 1934 inclusive), when $40,000,000 a year is spent, these percentages give an average of $20,000,000 a year for levees and of $7,000,000 a year for revetment and contraction works. The Bonnet Carré spillway will probably be completed in this time, at a total cost of, say, $10,000,000.

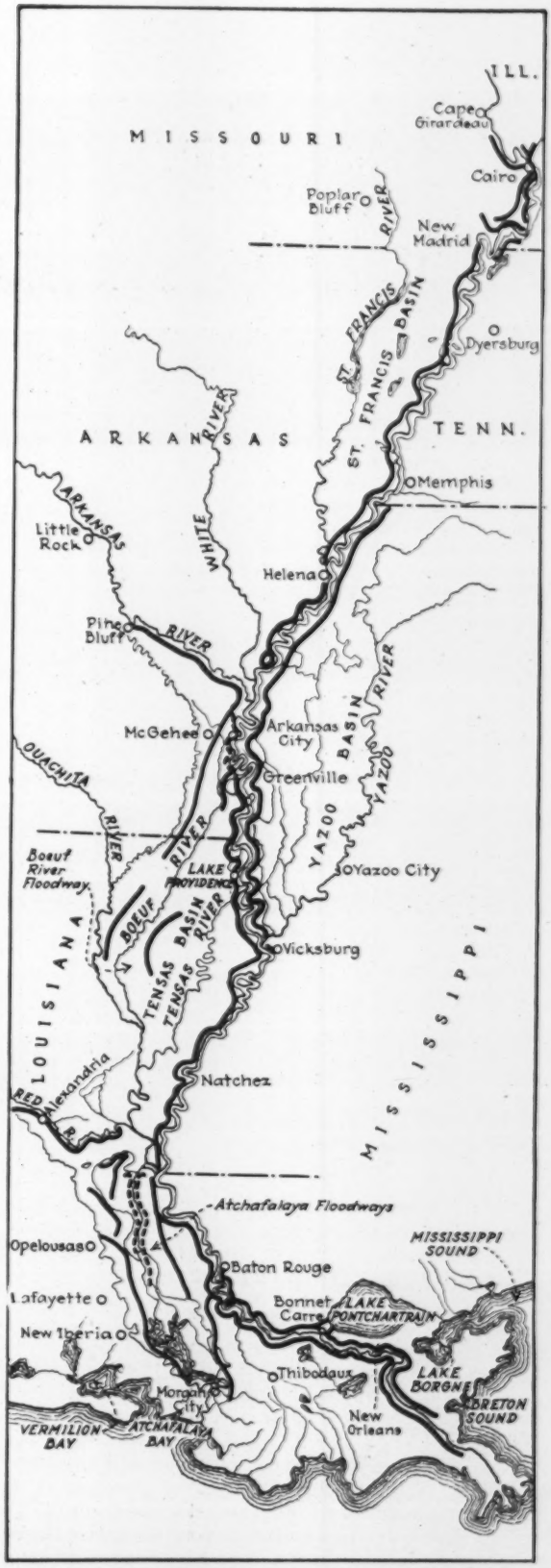
Work Volumes—The foregoing are money quantities. They may be transmuted roughly into volumes of work as follows: At 3 yd. for a dollar of earth in levee the volume of earth moved annually will be 60,000,000 to 75,000,000 cu.yd. Assuming $5,500,000 for revetment aside from contraction works and a cost per mile of $250,000, some 22 miles of concrete revetment will be constructed each year.

Contracting Opportunities—There is virtually no opportunity for contractors in the second group of activities in the above classification. On present outlook they will be handled directly by the government engineers and their forces and equipment. The equipment manufacturer and materials producer have in these activities, however, a large opportunity for business and service.

Considering now the first group of construction activities, the contractor will have to compete in bidding with the government engineers in so far as they have equipment for doing the work. Presumably competition will continue on the present basis: To the engineers' estimate of cost 25 per cent will be added, and to the contractor's bid 4 per cent will be added for supervision and inspection; the low bid then takes the work, with preference given to the contractor if the bids are virtually equal. In revetment construction (either concrete or willow mat) the government engineers have all the equipment that is required until a much larger volume of this work is undertaken. They are now doing all revetment work. In contraction works, largely wing-dam or hurdle construction, the government engineers are outfitted to carry on only a part of the work and are contracting for a considerable portion. For the largely increased volume of levee construction there is a decided shortage of government plant and it is of no higher type than is available to the contractor. The contractor, then, has a wide field for competition with the government in levee construction.

Directing Organization

By the flood-control act of 1928 a new set-up is created for handling Mississippi River work. The Chief of Engineers, U.S.A., under the Secretary of War is in control. The Mississippi River Commission, previously in authority, becomes an advisory investigating and plan-



LEVEE LINES OF THE MISSISSIPPI RIVER FLOOD-CONTROL WORKS

To avoid confusion, all indication of overflow and protected areas is omitted from this map and also all other topographical features except streams.

ning body and the executive agency for the immediate direction of construction. As at present organized it is composed of three army engineers, two engineers from civil life, an official of the Coast and Geodetic Survey and a business man. The president is Brig.-Gen. T. H. Jackson, Corps of Engineers, U.S.A. The headquarters of the commission remain at St. Louis, Mo.

The former organization of the commission for carrying on river work, partly functional and partly district, has been changed to virtually a straight district organization. The districts and their present engineers in charge of work and disbursement under the commission are as follows:

Rock Island Engineer District—Mouth of Illinois River to Rock Island, Ill., 273 miles. Major C. L. Hall, Corps of Engineers, U. S. Army, Room 251, Federal Building, Rock Island, Ill.

St. Louis Engineer District—Upper limits of Memphis Engineer District to and including mouth of Illinois River, 190 miles on left bank and 181 miles on right bank. (Also includes all commission work on Illinois River.) Major John C. Gotwals, Corps of Engineers, U. S. Army, Room 428, Custom House, St. Louis, Mo.

Memphis Engineer District—Cape Girardeau, Mo., on right bank and Thebes, Ill., on left bank to mouth of White River on right bank and to Coahoma-Bolivar County line, Miss., on left bank, 446 miles on the right bank and 411 miles on left bank, of which Cape Girardeau to Cairo, 54 miles on right bank, and Thebes to Cairo, 46 miles on left bank, is restricted to levee work. (Also includes all commission work on Ohio and White rivers and all dredging operations of the commission below Cairo, Ill.) Major F. B. Wilby, Corps of Engineers, U. S. Army, 1006 McCall Building, Memphis, Tenn.

Vicksburg Engineer District—Lower limits of Memphis Engineer District to Warrenton, Miss., 218 miles on right bank and 244 miles on left bank. (Also includes all commission work on Arkansas River.) Major John C. H. Lee, Corps of Engineers, U. S. Army, P. O. Drawer 667, Vicksburg, Miss.

New Orleans River District—Warrenton, Miss., to Head of Passes, La., 458 miles. Major W. H. Holcombe, Corps of Engineers, U. S. Army, Riverfront at Burdette St., New Orleans, La.

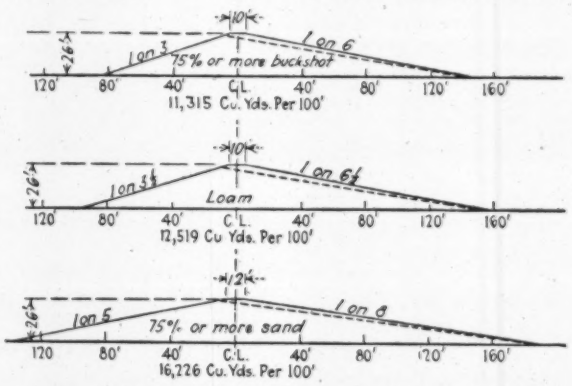
This organization is given somewhat circumstantially because it will be the district engineers with whom contractors will have to deal primarily. In each district the district engineer, under the commission and the Chief of Engineers, plans, allocates, contracts and directs all improvement work. The district organizations vary somewhat. In general there is subdivision into areas, with an area engineer in charge of all construction in each. There are, according to the district, various other subdivisions, the approach to all of which is through the district engineer. In brief, the district engineers are the direct contact officials for contractors or others having business on the work.

Levee Construction

As previously stated, the greater opportunity for contractors is on levee construction rather than on revetment construction. Levee work presents a different set of conditions than does revetment. At the outset the volume (60,000,000 to 75,000,000 cu.yd. a year) of work is far beyond the levee-building equipment of the government to handle. With the task of greater levees—whether new levee or enlargement of old levee—the government starts from a position no more advantageous than does the contractor. Its largest plant and best working methods are no larger and better and no more nearly adequate to the new task. Like the contractor, it must devise new plant and methods.

On levee work, also, experimentation is within the hazard which private business can afford. Even the heaviest plant for levee construction costs only a fraction of the plant cost for concrete revetment. Again, earth moving and embankment construction are old and familiar processes to contractors and equipment manufacturers, and they approach an undertaking of either kind with a wealth of accumulated experience. This is demonstrated by the experience of the present year; contractors have introduced novelties in combinations of construction methods and equipment which give high promise of wide usefulness.

Sections and Volumes—Under the plan now being carried out the old M.R.C. levee section is radically changed. The banquette is eliminated and slopes and crown are varied according to classes of materials. An example is furnished by the sections shown for the Vicksburg engineering district. These are the tentative sections (maximum) to which new levees will be built and old



MAXIMUM LEVEE SECTIONS, VICKSBURG ENGINEER DISTRICT

These are tentative sections. Tests are now in progress to determine actual slopes of seepage lines. If tests show material variation from slopes assumed, the sections will be modified accordingly.

levees enlarged. Tests are now going on to determine seepage line slopes, and should they be found materially different than those shown change of sections is likely to follow.

Except in the matter of sections, the old M.R.C. specifications will prevail in the new work, at least for the present. There is the likelihood of change as new methods of construction develop, but the change will grow out of developed methods and not precede them.

There is no standard-volume levee section. The volume per station (100 ft.) may vary between wide limits on different parts of the same project. This is particularly true of enlargement work—and a large part of the levee construction is enlargement. Nor is there any standard of placement of the added section with respect to the old section. In general the placement will be largely on the river side, but often also the back slope will be extended. Placement is of course more standardized for new section (and all setback levees and the floodway levees are new section), but this is no more standard-volume section than is enlargement.

Construction Conditions—Construction conditions vary. Location, access, wooded condition, borrow areas and haul, materials and high-water hazards differ with every project. Each therefore is a separate problem in construction attack and has to be solved individually. This does not mean that no general classification is possible. This is particularly true with respect to equipping

the work. There are, for example, projects that are distinctly tower-machine operations and others where this effective levee-building tool is distinctly inapplicable. So is the fact with respect to other types of equipment. But the truth remains that in general Mississippi levee construction is only in a limited measure standardizable in methods and equipment. The new work is less so than was the old.

River Hazards—The new contractor has a major task in educating himself to the hazards of river level fluctuations. Without the evidence of actual vision it is difficult to sense what changes in batture conditions follow the normal rise and fall of the river. Changes in batture conditions mean changes in construction conditions, for it is from between levee line and river bank that the earth for levee embankment must come. A moderate river rise in many locations may easily flood borrowpits through the bayous and draws extending in from the river. Greater rises may inundate the whole batture. High-water protection of his borrowpits is, then, a major preparatory task for the contractor. A co-ordinate problem is to plan and schedule the work so that, in times of rise, shift of operations can be made to high portions of the batture and work be continued while the rise may be inundating the lower portions. There are no two like situations; there exist high battures unaffected by normal river fluctuations and low battures that are flooded by every rise. The fact to be emphasized is that always the river is to be considered as a hazard to be prepared for.

Methods and Workmanship—Levee construction has always been of the materials closest at hand. These throughout the whole delta region are buckshot clay, silt and sand and their natural combinations, particularly those of sand and silt. As indicated by the tentative sections illustrated, these materials require different levee prisms because of their different seepage line angles. None of them when dry offers any particular problem in handling and the sand when wet is no more than wet sand familiar to every earth mover. But when wet the silt, or "loam," is about the softest mud, and wet buckshot is about the stickiest mud imaginable. Both should have careful study by contractors who have not had experience in excavating and placing them in embankment. Always, too, these materials, except in case of wagon or scraper fill where placing in layers was natural procedure, have been put into embankment by continuous dumping to gross fill.

As of present advices the same embankment-building methods as in the past will be continued in the new work. In the new work, however, there are two possible construction changes which can develop. The necessity of going farther afield for borrow, introducing long haul perforce, offers an opportunity for choice of material that has not before existed. With some freedom of selection it follows naturally that more attention may be given to prescribed location, sequence and methods of placement. These are at present merely speculations, but contractors may advisedly keep the possibilities before them in their levee contracting planning.

Borrow Location and Depth—Previous levee construction has been largely a one-equipment-type operation. The borrow was close enough generally to permit embankment construction by equipment that both excavated and placed the material or by small digging and carrying units. There will be in the levee setbacks and in the new floodway control levees many opportunities for the use of the old, proved machines just as they have been used in the past. In main river levee enlargement, however, their utilization will be chiefly to rehandle into embankment material brought within reach from distant borrow by other excavating and hauling devices.

This brings us to the outstanding construction condition of the main river levee work—principally levee enlargement. Haul is a controlling factor. The old levee work has used up the near-by borrow. Material must be brought in from comparatively distant pits.

Also, getting borrow becomes a different problem in levee work from most earth-handling operations into embankment. Generally borrow on the land side is not allowed, and when it is allowed the location and character are definitely specified. On the river side, the old pits where the work is levee enlargement cannot be deepened except they are less than specified depth. Specified depth is a cut of 1 on 2 to 3 ft. depth and then a cut deepining away from the levee at a slope of 1 on 50. For landside borrow the slope is 1 on 100. There are various other requirements and some variations from these slopes, but the main condition that the borrow cuts are exceedingly shallow is persistent and it has to be remembered by the contractor, as it has a deciding effect on equipment and mode of procedure. In brief, the contractor has to get his borrow from specific locations and with a specified pit depth. Another practical factor to be regarded is borrowpit clearing and grubbing; these may be considerable tasks in places.

What Should the Contractor Do?

At the beginning the contractor's chances will be on levee work. Only a small amount will be spent for revetment at first, and the government engineers will keep that work in their own hands so that they can spot it here and there as they choose. For levee work the first task of the contractor is reconnaissance; the second is to live on the job. In making reconnaissance: (1) take time, (2) learn what government practices and results are, (3) seek out the best contractors and learn their problems and practices, (4) study the river so as to take advantage of its service, but particularly to learn how and where its high-water attacks will be, (5) study projects enough to absorb the fact that each is an individual problem in materials, access, water conditions and servicing, and finally (6) remember that the government is a competitive bidder for every contract.

The second article, next week, will describe and analyze levee-construction methods and particularly the problem of long-haul from borrow and its possible solution.

Enlarging a Paris Terminal

Work has been started on the enlargement of the Paris terminal station of the Eastern Railway, of France, to provide 30 platform tracks and a new station building. This work, which is to be completed in 1931, is the sixth enlargement since the station was opened in 1855, with two platform tracks and a four-track approach. A few years later four station tracks were added and two more in 1878. In 1889 there were fourteen tracks converging into six main tracks; two more station tracks were added in 1900 and again two more in 1918, making a total of eighteen tracks, which is the number now in service. Traffic has increased rapidly, the annual number of outbound passengers rising from about 2,000,000 in 1878 to 4,000,000 in 1889, to 8,500,000 in 1900, to 16,000,000 in 1918 and to 25,500,000 in 1925.

Guniting Steel True to Cross-Section and Alignment

Exact Lines and Planes and Sharp Arrises Secured With Flat Boards and Angle Strips Made of Two Boards Side to Edge

To INDICATE CRAFTSMANSHIP in guniting structural steelwork is quite as much a task of illustration as of description. In this article, therefore, illustration is a component part of the presentation and the views and sketches should be perused as carefully as is the text. It is one of the marvels of present-day construction skill that complex steel frames are covered with thin coatings of gunite, placed true to sectional contour and with every surface and arris and line as sharp and true as ordinarily they are when concrete is molded in forms. This article describes the methods and devices employed. —EDITOR.

THE incasing of steel structures with gunite as it is now regularly practiced calls for special craftsmanship. Merely to plaster the steel with a coating of cement-sand mixture which will adhere is not enough. This coating is now required to preserve in outline the distinctive forms of the steel members with all the arrises sharp and all the surfaces true. In modern practice a gunited plate girder, for example, is as distinctively a plate girder in appearance as it was in its original naked steel condition—chords, web and stiffeners are all clearly and sharply delineated. This same preservation of characteristic section and outline is maintained in guniting rolled I-beams, built-up columns, struts and diagonals and gusset-plate braces and connections. The steel is coated with gunite and not buried in gunite. This distinction is clearly indicated by Figs. 1 and 2.

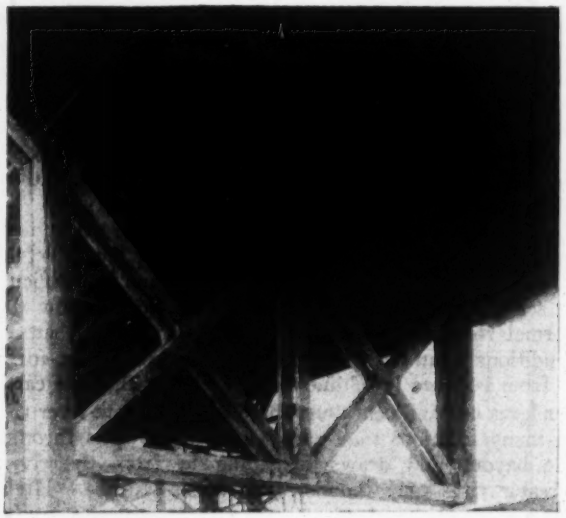


FIG. 2—CROSS-BRACING BETWEEN COLUMNS OF HOLLAND TUNNEL VIADUCT IN JERSEY CITY, N. J.
Columns are of poured concrete and braces and girders are gunited. A comparison of lines and surfaces is interesting.

These illustrations call for more particular notice. Fig. 1 is a view on a portion of the new station structure at Easton, Pa., for the Lehigh Valley Railroad. Both columns and diagonals are of H-section, the diagonals having latticed webs. Some of this uncovered steel work is shown by Fig. 3. It is to be noticed that the characteristic sections are preserved and that arrises and surfaces are sharp and true. The second example, Fig. 2,

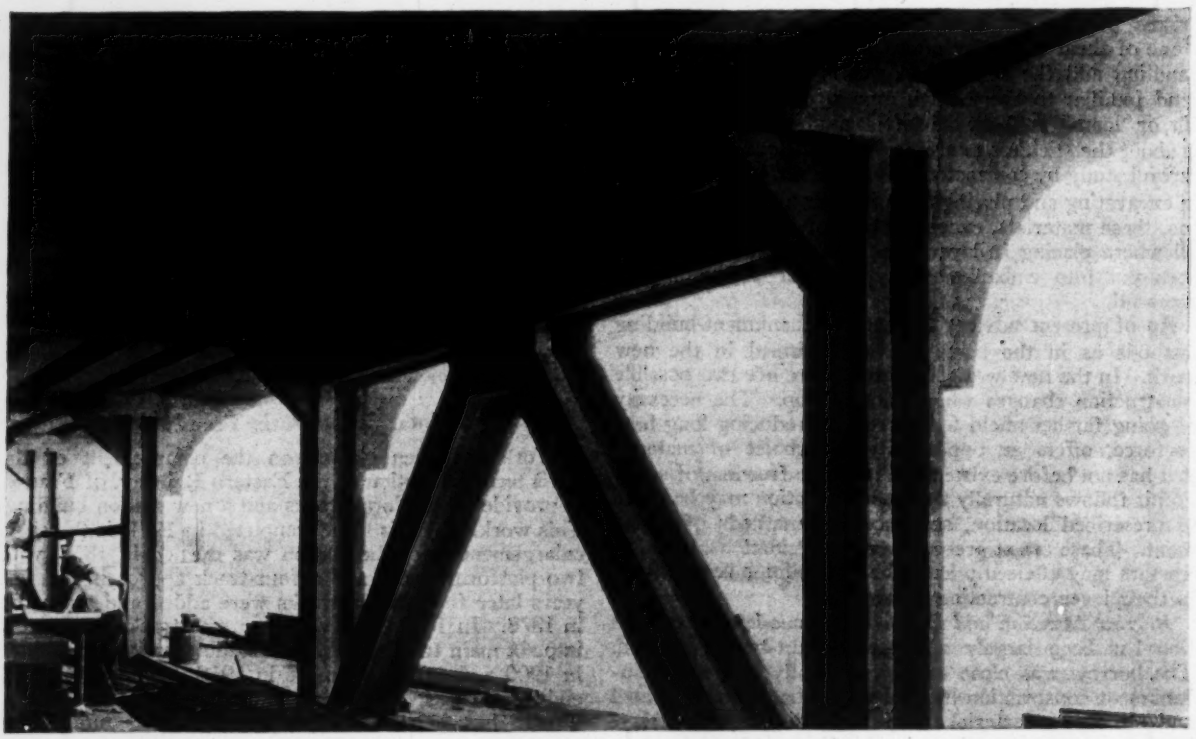


FIG. 1—GUNITED STEELWORK ON LEHIGH VALLEY RAILROAD STATION AT EASTON, PA.
Note the H-section posts and diagonals, gusset plate braces, brackets and beams and girders. Outer edges of posts left rough, as a brick wall will cover these parts.

shows the gunited steel work of the viaducts on the New Jersey approach road to the Holland vehicular tunnel at New York City. Observe the split cross-trusses at expansion joints; the cross-truss incasement, and the floor plate-girders, with flanges, webs and stiffeners clearly delineated, and note again the true line and surface throughout. Neither the work at Easton nor that at Jersey City is exceptional. It represents every-day performance on steel incasement with cement guns. How is it obtained with a material shot into place through a nozzle by compressed air?

The vehicular tunnel road viaducts through and out of Jersey City, N. J., will be taken as examples, with supplementary illustrations from the Lehigh Valley Railroad station construction at Easton, Pa. On the tunnel road work the specifications provide that the gunite over the webs of the various members shall be 1½ in. thick and that the bottoms and outer edges of

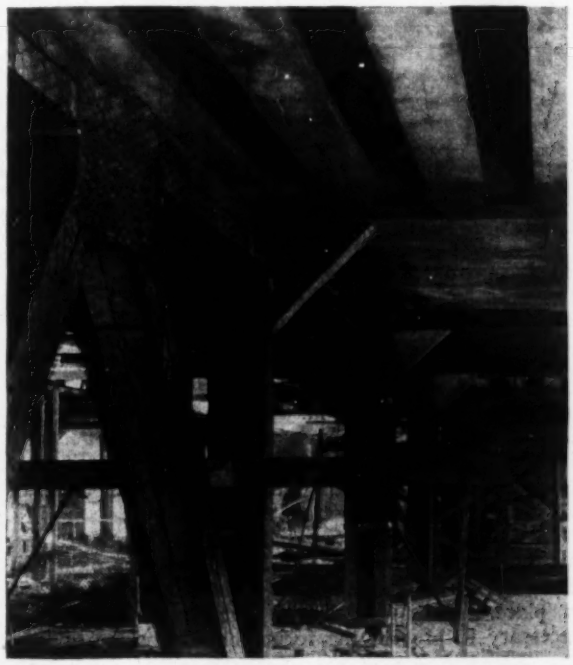


FIG. 3—REINFORCEMENT AND SHOOTING STRIPS ON LEHIGH VALLEY RAILROAD STATION
This exposed steel work being prepared for guniting is the same (not identical) as that shown gunited in Fig. 1.

flanges shall be covered by no less than 2 in. The specifications also provide that the gunite shall be reinforced by a mesh held firmly in position just clear of the steel member. The procedure is as follows:

Placing Reinforcement—For small members the mesh is bent around the flanges and across the webs so that with a few ties where the laps come it retains its position by its own stiffness. Stated in another way, the member is wrapped with a layer of wire mesh which is bent and pressed to conform closely to every contour of the section. Figs. 3 and 4 show clearly the manner and the appearance of this wrapping. It is carefully done so that the mesh does not hug the steel but still conforms to its sectional contour. Also the bending and pressing of the mesh and the wiring at laps are so performed that the mesh wrapping will not spring out of shape after being placed. The operation, of course, is by hand, but with skilled workmen it is very rapid.

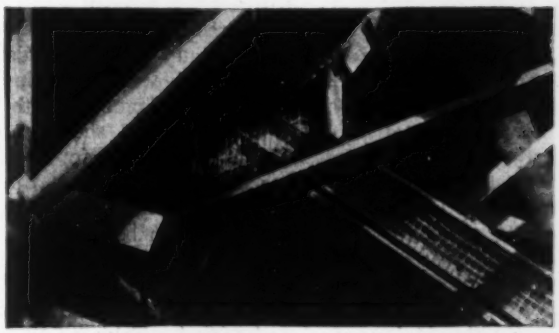


FIG. 4—REINFORCEMENT AND SHOOTING STRIPS FOR CROSS-BRACING ON HOLLAND TUNNEL VIADUCT
For these small section members the reinforcing mesh is bent and pressed to shape and wire-tied at laps. Also the members' I-sections are incased in a rectangular section of gunite. Only in the larger members does the gunite section conform to the contour of the steel section.

Where the webs are broad as in the case of plate girders (Fig. 5) the mesh is held to the webs by ⅜-in. rods. For these rods holes are punched through the webs when the girder is fabricated. These holes are located close to the edges of the flange angles and are spaced about 3 ft. longitudinally of the girder. Generally two rows of holes (top and bottom) are enough, but if the web is very deep, a middle row of holes may be required. Vertically the holes are directly above each other. Through these holes hairpin wires are pressed and twisted to clip vertical ⅜-in. rods, cut to fit between flanges and placed one on each side of the web. These rods serve the double purpose of (1) furring strips to keep the mesh from contact with the web and (2) anchors to hold the mesh true to position. The mesh is tied to the webs and bent around the flanges as shown by Fig. 5. In turning the edges of the flanges care has to be taken to see that the mesh does not hug them; otherwise the mesh is pulled as taut as practicable. All laps are firmly tied with wire. The member is now ready to be gunited.

Placing Shooting Strips—To assure a shapely covering, with flat surfaces, sharp arrises and fillets and true alignment, and particularly to insure proper covering of

FIG. 5—REINFORCEMENT AND SHOOTING STRIPS FOR LARGE GIRDERS, HOLLAND TUNNEL VIADUCT
Observe the angle shooting strips for flanges and the flat shooting strips for web stiffeners. Observe how the reinforcing mesh is molded around the flanges and is held to the webs by furring rods wired together through holes in web.

the edges of flanges and stiffeners, alignment boards known as shooting strips are erected. These strips consist of boards or of angles made up of two boards. Usually 1-in. boards are used. Fig. 3 shows the shooting strip for the under web-face of a lattice diagonal and the corner shooting strips for a post. Fig. 4 shows the shooting strips for intersecting diagonals and for their gusset plate connection. Fig. 5 shows the shooting strips for plate girder flanges and stiffeners. Fig. 6 shows the shooting strips for an inverted T-section bottom chord of a cross-truss between columns.

It will be noted that the shooting strips either mold every arris and surface or give the line by which it may be truly shaped by trowel and screed. Taking first a plate girder, the shooting strips are placed as shown by sketches 1 and 2 of Fig. 7. The flanges are gunited first, pointing the nozzle as shown by the arrows *a* in sketch 1. These operations cover the flanges with gunite

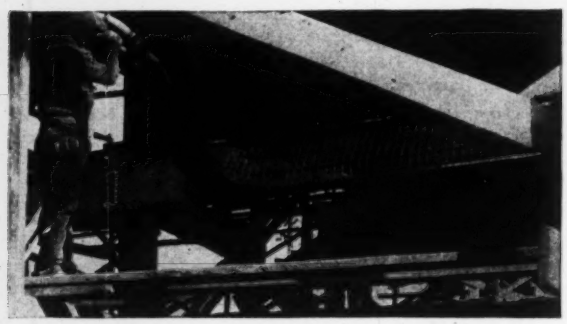


FIG. 6—GUNITING A T-SECTION CHORD FOR CROSS-BRACING SHOWN BY FIG. 4

Notice how the gunman builds up to the plane defined by the edges of the shooting strips. When the gunite has hardened to troweling consistency, this surface is perfected by troweling or screeding.

about as indicated by the vertically hatched areas. The dotted lines indicate the reinforcement. The next step is to shoot the web stiffeners as shown by sketch 2, the arrows indicating the pointing of the gun. With this done, it will be noted all flange and stiffener lines have been established and there remain only the flange top and bottom and the web plate proper to be coated as shown by the horizontal hatching. This is done by shooting as the arrows *b* and *c* point in sketch 1. Sketch 4 shows the shooting strips and sequence of shooting in incasing I-beam, struts and braces. An I-beam post is gunited as shown by sketch 4. Sketch 5 shows the shooting strips for a latticed diagonal.

Guniting Procedure—As the shooting strips must give line and surface, they are carefully located. The next step is to apply the gunite. This is done by directing the line of flowing material as nearly normal to the surface as possible (Fig. 8). The gunite is brought out practically to the final completed thickness in one coat, if it can be done, after which the webs or other exposed surfaces are trimmed

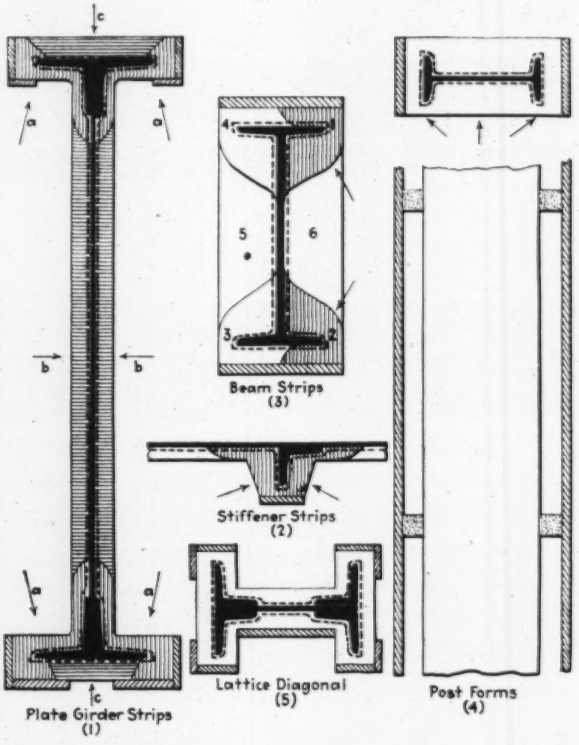


FIG. 7—DIAGRAMS OF SHOOTING STRIPS AND GUNITING SEQUENCES

to proper lines. This trimming leaves a surface which subsequently must be finished by a flash coat. This flash coat is from $\frac{1}{8}$ to $\frac{1}{4}$ in. thick, and is itself generally finished by brushing with a whitewash brush wetted with clean water. This finish coat is not applied until after the removal of the shooting strips and the completion of the incasement of the bottom of the flanges.

In Fig. 8 it will be seen that after the edges are shot and the forms removed there is left a space approximately the width of the flange and of full depth with no gunite in place. This method of forming or stripping is necessary to prevent the formation of pockets of inert

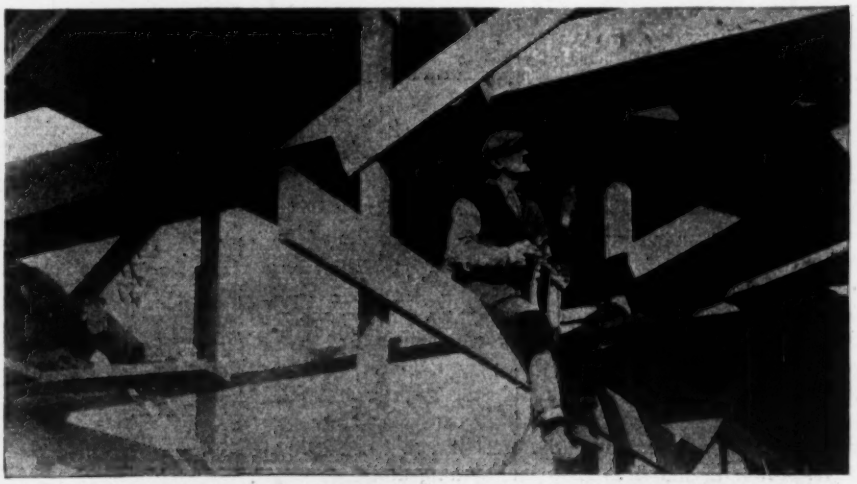


FIG. 8—GUNITING BOTTOM OF CHORD FLANGE

Shows the alignment on the edges after the angle strips have been withdrawn; also shows how the gunite is shot into the space on the bottom between the angle strips. Note that the line of flowing material is impinged normal to the surface. This view clearly shows how sand pockets are eliminated by this method of stripping.

material (sand pockets) and also to permit of placing the material on the flange bottom by shooting normal to the surface and thereby obtaining a gunite which will positively resist destructive action. It is, therefore, necessary that the bottom leg of the stripping angle shall not be wider than 3 in., or 4 in. at the outside.

The gunite is applied to the bottom of the flange in two or more layers. As gravity tends to affect the stability of gunite placed on an overhead surface, care must be taken to eliminate this danger. Applying the gunite in coats not exceeding 1 in. thick does this. Subsequent to placing the final coat the surface is cut to the lines established by the adjacent previously shot edges and over this surface as well as the webs the flash coat above described is placed and finished.

It is to be noted that the finish on this final coat can be of any texture or architectural treatment desired, this being governed entirely by the expenditure warranted. Fig. 1 shows the finish on the steel incasement of the station of the Lehigh Valley Railroad at Easton, Pa., where floating was required.

In Figs. 4 and 6 there is shown the method of stripping the column braces. It will be noted that on these vertical and diagonal members the strips consist merely of single boards held firmly in position at the required distance out from the steel and with the outer edges on the lines of the completed surface. Into the space between these planks the gunite is shot in one or more coats and finally cut to the lines established by these grounds or strips. On the removal of the strips the space between the corners is finished as described for the bottom of the flanges. In small members the space between the legs of channels is filled completely out to the line of the edge protection, but if large members are used in columns or diagonal members, angle strips are placed which will permit of following the sectional contour in the same manner as with beams.

In Figs. 4 and 6 it will also be noted that the mesh is placed in the same general manner as for beams. Frequently, however, in smaller members it is good practice to eliminate the use of the rods, as it is possible to bend the mesh to a complete coverage of the surface and practically to follow the contour without the necessity of tying other than at the laps.

In those members where stiffeners are used it is the custom on the Jersey City viaducts to place a shooting strip 3 in. wide vertically along the line of the stiffener and held in position at 1½ in. out from the edge. This enables the operator to shoot the gunite normal to both sides of the stiffener, and the finish is obtained by cutting to the edges of the strip.

Guniting steel so far as it is a matter of equipment and general directions has been described. There is much more which lies in the skill of the gunman and nozzleman. The gunman has to know how to serve the nozzleman with a steady supply and pressure of material and the man at the nozzle has to be skilled by experience in building up his gunite coating so that it will stay in place on surfaces standing at every angle. This skill and craftsmanship are accomplishments which come from experience and natural aptitude and cannot be described and imparted.

Building a Concrete Reservoir for Portsmouth, Ohio

Hillside Location Causes Unusual Shape—Traveling Rehoist Tower Serves Chutes—Gantry Carries Wall Forms

By R. J. Turrell

Assistant Engineer, Hodges Construction Company, Cincinnati, Ohio

A RESERVOIR of 22,000,000-gal. capacity now being built for the water-works department at Portsmouth, Ohio, has the peculiar feature of being U-shaped or horseshoe-shaped in plan to conform to the contour of the ground. It is peculiar also in that each leg is on

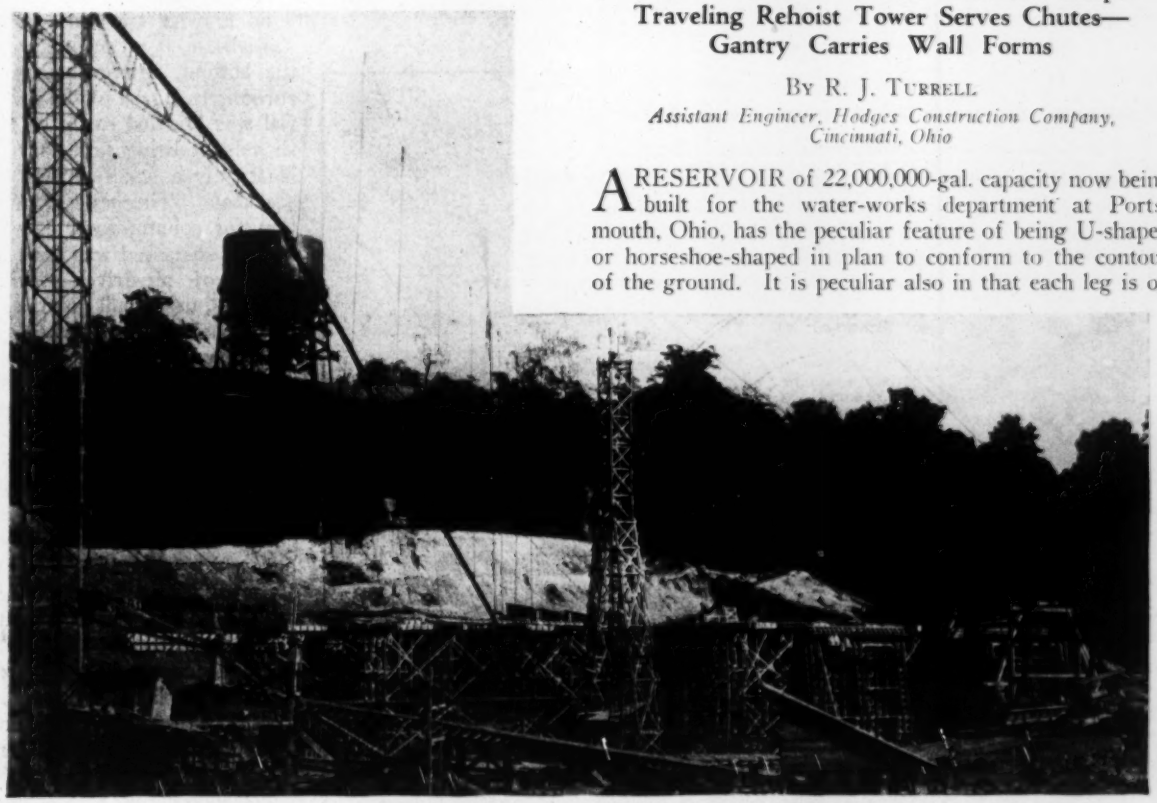


FIG. 1—CONCRETING PLANT FOR RESERVOIR AT PORTSMOUTH, OHIO

Steel hoisting tower and chute at left. Timber rehoist tower in middle is mounted on traveling platform and carries boom with suspended chute. Note flaring base of this tower to give stability in moving. At right, timber gantry straddles wall and carries wall forms. In foreground is cable incline on trestle for batch cars serving mixer at steel tower.

a hillside, so that the inner side is a paved slope while the outer side is a reinforced-concrete retaining wall. In the construction work, interesting features are the use of a traveling concreting tower and a traveling gantry which straddles the concrete wall and handles the forms, which are made up in large units. The construction work is shown in Fig. 1, with the general design of reservoir and layout of construction plant in Fig. 2.

This reservoir, north of the city and at an elevation of about 150 ft. above the level of the business section, will maintain a minimum pressure of 75 lb. in the mains and will provide for about three days' supply, based on the present average daily consumption. In addition, a 400,000-gal. steel tank on a 75-ft. steel tower is being erected on a hill above the reservoir, to give ample pressure to the hilltop sections of the city. The top of this tank, shown in Figs. 1 and 2, is 370 ft. above the business district. Two horizontal two-stage centrifugal pumps of 400-g.p.m. capacity, driven by 40-hp. electric motors, will pump water from the reservoir to the standpipe.

At present the city has a 7,000,000-gal. reservoir, which is about sufficient for one day's supply. As the population has increased from 40,000 in 1921 to 60,000 in 1928 and is still growing, it was desirable to have the additional storage capacity available as soon as possible. The contract was let in July, 1928, and it is expected to have the reservoir ready for service some time this month.

This new reservoir is in sidehill excavation, as noted, with a low concrete wall and a paved slope on the upper side, while the end and lower side are formed by a 30-ft. retaining wall of reinforced concrete, shown in Fig. 3. For the floor a layer of gunite 3¾ in. thick will be applied on the graded surface of the ground, reinforced with wire mesh. Reinforced-concrete columns 24 in. in diameter and spaced 25 ft. c. to c. each way will support beams and girders carrying a slab roof, upon which will be a shallow earthfill covered with sod.

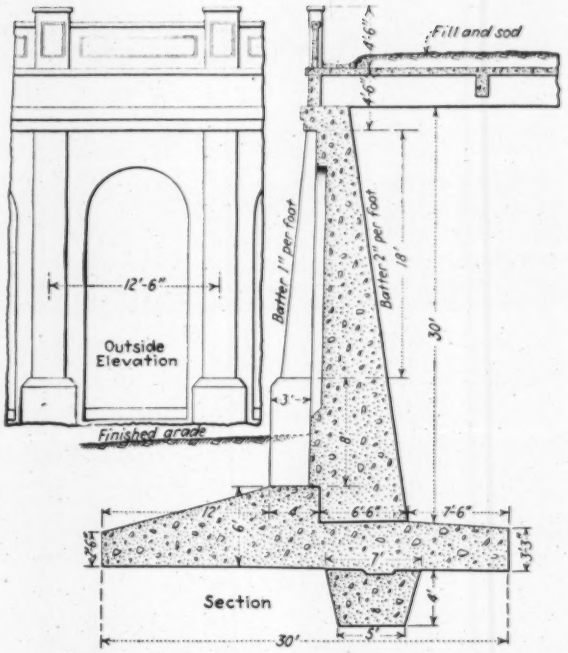


FIG. 3—SECTION OF 30-FT. RESERVOIR WALL

Excavation was handled by four steam shovels with ¾-yd. buckets and crawler tractions. Most of the material was hauled away by motor trucks, the haul averaging less than ½ mile. About 35,000 cu.yd. then remained, which was hauled by horsedrawn dump wagons and by tractors with large trailers on crawler tractions. The soil is stiff clay, except toward the bottom, where shale was encountered. All of the material was handled easily by the shovels, it being necessary to blast only a small portion of the shale. The hand excavation for column footings was in hard shale and was done by means of air-driven paving breakers, using bull points and chisel tools.

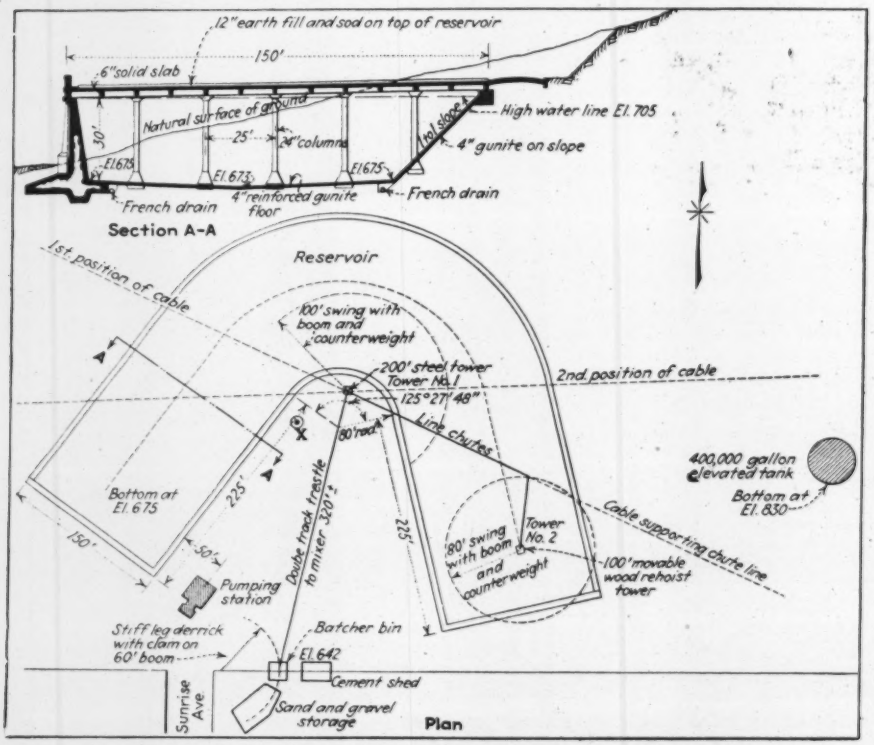


FIG. 2—LAYOUT OF CONSTRUCTION PLANT FOR RESERVOIR

Concreting Plant—The concrete equipment layout is shown in Fig. 2. Sand and gravel storage piles were placed near the end of Sunrise Ave., so as to be accessible by truck from the street. Aggregates are batched with a 72-yd. bin, which is loaded from the storage piles by a steel stiff-leg derrick with 60-ft. boom and ¾-yd. clamshell bucket. On a double-track wood trestle from the batcher plant to the mixer, a distance of 300 ft., run dump cars pulled by a gasoline engine, each car containing the materials for one batch of concrete. The mixer is placed at the base of tower No. 1, a 200-

ft. steel tower, located as nearly as possible at the center of operations. The concrete is conveyed by means of line chutes suspended from a cable and extending to the bottom of tower No. 2, where it is rehoisted and distributed by boom and counterweight chutes into the forms.

Tower No. 2 is of standard wooden construction, 100 ft. high, mounted on a timber platform and braced laterally so it can be moved on large wooden rollers. An engine mounted on the platform takes care of hoisting the bucket in the tower and also moves the tower forward under its own power. Both towers are shown in Fig. 1, which is taken from position marked *A* on Fig. 2. When the concreting is complete on one wing to a point where it can be reached from the main tower, the cableway carrying the chute line will be moved to a second position, as shown on the drawing. Then the remaining concrete on the opposite side will be poured, the movable tower and line chutes being used as described above.

The footing for the main wall and part of the column footings were poured ahead of the other concreting with a paving mixer. The materials were batched at the gravel plant and hauled direct to this mixer by trucks. The use of this portable mixer gained considerable time, as this concreting operation progressed independently of the main concrete plant.

Form work for the main wall is somewhat unusual due to its size. Forms were constructed of 1¾-in. tongue-and-groove sheathing on 4x4-in. battens. The form

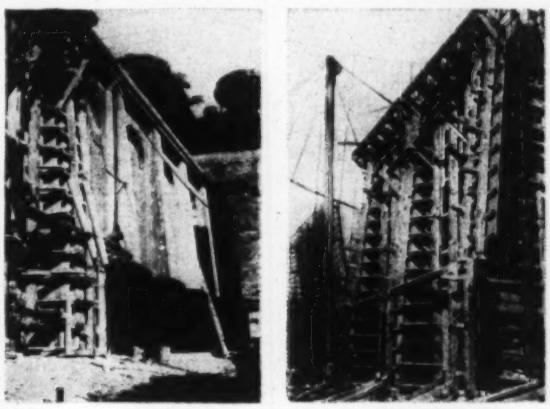


FIG. 4—CONCRETE WALL AND FORMS
At left, forms in place and part of finished wall exposed. At right, section of forms and placing of steel reinforcement.

work was made up in panels and assembled into units 25 ft. long, which were tied together with 2x6-in. walers, running vertically. Each 25-ft. unit was tied horizontally by means of steel channels, which were also used for raising and moving the forms. Fig. 4 shows sections of form work in place and also a portion of the completed wall.

After the forms were assembled they remained in units 25 ft. long and 30 ft. high, held together by means of ¾-in. tie-rods. A wooden gantry was constructed, which straddled the wall and ran on a track on the main wall footing. This is shown at the right in Fig. 1 and also in Fig. 5. After the rods were released, the forms were removed by jacking them away from the concrete and then suspending them from the gantry. The gantry was moved ahead on the track to a new location and the forms were then lowered and tied in position, ready for another pour. Three units of form work were constructed and re-used over and over for the entire wall.

FIG. 5—GANTRY CARRIES WALL FORMS

All form work was detailed by the contractor's engineering department and built on the job in a mill erected for that purpose.

Concrete for the entire job is being proportioned by the water-cement ratio method, with accurate control maintained at all times. Concrete of 2,500-lb. strength with a 4-in. slump is being used in the main walls and 2,000-lb. concrete with a 6-in. slump in the roof slab and other thin sections. The floor of the reservoir is 3¾ in. of gunite, 1 : 3 mix, reinforced with 4x4-in. welded wire mesh. The gunite is to be applied in three coats: a 1-in. layer is placed on the ground and the mesh laid on it, then a 2-in. layer is placed over the mesh and a final ¼-in. layer is applied as a flash coat. The exterior surface of the main wall will be given a ¼-in. flash coat of gunite to cover the form marks and other irregularities and to give a finished surface.

Estimated quantities are as follows: general excavation, 131,000 cu.yd.; concrete in main wall, 12,600 cu.yd.; concrete in roof slab and columns, 4,600 cu.yd.; gunite floor, 113,500 sq.ft.; gunite on exterior walls, 49,000 sq.ft. The general contractor is the Hodges Construction Company, Cincinnati, Ohio, of which C. R. Maris is chief engineer and the writer is assistant engineer; O. C. Andrews is superintendent of construction, with J. A. Kashbaum as assistant superintendent. The elevated tank is being erected by the Chicago Bridge and Iron Works, and the pumping equipment is furnished by the Dravo-Doyle Company, Cleveland, Ohio. The reservoir was designed by Hiller & Anderson, consulting engineers, Cincinnati, Ohio. All work is under the supervision of John R. Lynn, director of public service, Portsmouth, Ohio, and Charles S. Stevenson, city engineer.

Mount Whitney Elevation Is Determined

The elevation of Mount Whitney has been determined by the U. S. Coast and Geodetic Survey as 14,496 ft. according to a recent announcement. This work resulted from co-operation with the Carnegie Institute in testing the stability of the earth's surface in regions of seismic activity, a study which has been conducted in southern California during the past six years. Surveys include determination of points by triangulation to establish the geographic position and by precise leveling, as in the case cited, to fix the elevation. The party which carried the level line from an 8,000 ft. elevation to the summit was under the direction of J. H. Brittain, of the Coast and Geodetic Survey.

Continuous Truss Highway Bridge Over Missouri River

Two 450-Ft. Spans Crossed by 900-Ft. Truss at St. Joseph, Mo.—Silicon Steel and Riveted Construction

By L. J. Sverdrup

Sverdrup & Parcel, Consulting Engineers, St. Louis, Mo.

A 900-FT. continuous riveted truss covering two equal spans of 450 ft. 4 in. c. to c. of piers is the distinctive feature of a highway bridge now being built over the Missouri River at St. Joseph, Mo. The project for a free interstate bridge to connect the highway systems of Missouri and Kansas at this point has been under consideration for several years and culminated in October, 1927, when arrangements were completed whereby the city of St. Joseph and the State of Missouri were to co-operate in the building of such a bridge.

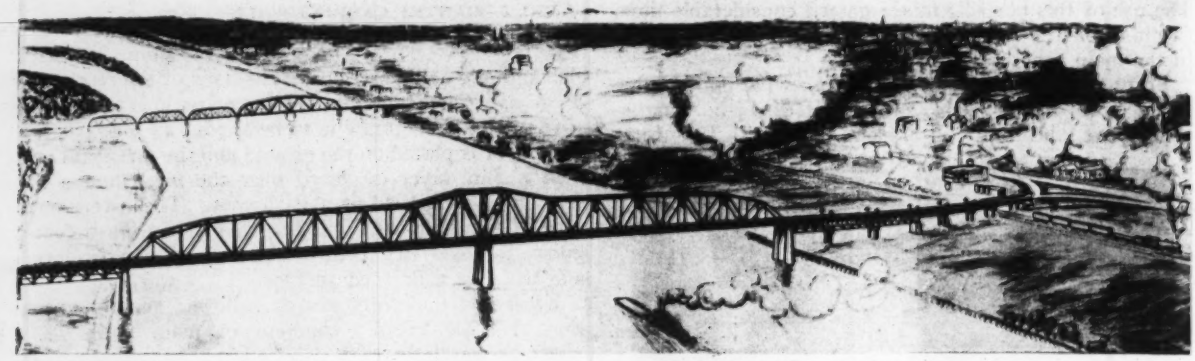


FIG. 1—BRIDGE WITH 900-FT. CONTINUOUS TRUSS
Highway bridge across the Missouri River at St. Joseph, Mo.

Funds for the construction of the east approach and pier 1 (at the east end) were contributed by the state, while the remainder of the cost of the bridge was to be borne by the city. It was also agreed that the State Highway Department should prepare the plans and supervise the construction of the bridge. Bids were received and the contract was awarded in April, 1928. Work on the substructure is now well under way.

This bridge is located approximately ¼ mile south of the present combined railway and highway bridge operated by the St. Joseph & Grand Island Railway. It has a 27-ft. roadway and no sidewalk is provided. On the east end the approach consists of three deck truss and five girder spans, terminating at a Y-embankment connecting with a main highway parallel to the river. On the west end four deck truss spans connect with a Kansas highway in line with the bridge. The location and general design of the bridge are shown in Fig. 1, and a typical cross-section in Fig. 2.

Structural Design—The salient features in the design of this bridge are the application of continuous trusses to relatively moderate span lengths, and the liberal use of silicon steel. Careful comparisons were made between simple span and continuous layouts, between silicon and carbon steel sections and between simple and subdivided panels.

A comparison of the continuous truss with two simple spans showed a saving of approximately $25,000 (about $13,000 in the superstructure and $12,500 in the substructure). This is roughly 7 per cent of the total cost of the main bridge. In comparing silicon and carbon steel in the original estimate, a differential of 1c. per pound was used. This showed a total difference of $30,000 in favor of the silicon steel. The contract unit price involved a difference of only 0.7c. per pound, so that the actual saving consequent upon using silicon steel wherever the size of member would justify it amounted to approximately $37,000. A comparison of subdivided and simple paneling showed a slight economic advantage in favor of the latter, and as it also had the advantages of greater simplicity of erection, lower secondary stresses and a more clean-cut appearance, it was adopted.

Specifications and Loading — The bridge was designed according to the specifications of the American Association of State Highway Officials, 1925, with modifications as noted below.

For live loads, the floor was designed for one 15-ton truck per panel on each of three traffic lanes spaced 9 ft. c. to c. The trusses were designed for a uniform load of 562 lb. per linear foot of one truss and a single concentrated load of 26,300 lb. An impact allowance of 30 per cent of the live load was used on all floor members. For the trusses, a value was used of I (in percentage) as determined by the formula $I = [0.8\ (L + 250) \div (10\,L + 500)]$ (in which L is loaded length), with the provision that this value should never exceed 30 per cent.

The maximum transverse wind pressure was taken as 30 lb. per sq.ft. on the area (in elevation) of one floor, two trusses and two handrails. Longitudinal wind pressure was taken as 50 per cent of the transverse wind pressure per linear foot of bridge. Normal temperature was assumed as 60 deg. F., with a maximum and minimum of 120 above zero and 20 deg. below zero, respectively.

The structure was tested for six possible combinations of loads, as follows: (1) Dead + live + impact; (2) dead + 30-lb. wind; (3) No. 1 + 15-lb. wind; (4) No. 1 + temperature; (5) No. 4 + 15-lb. wind; (6) No. 2 + temperature. For cases 2, 3 and 4, the allowable unit stress was increased 25 per cent. For cases 5 and 6 this stress was increased 40 per cent. Unit stresses adopted were as follows: Carbon steel: tension, 16,000 lb. per sq.in.; compression, 15,000 lb. minus $50\,l \div r$, with a maximum of 13,500 lb. Silicon steel: tension, 24,000 lb.; compression, 22,500 lb. minus $75\,l \div r$, with a maximum of 18,750 lb.

Design for Continuous Truss—A two-span continuous

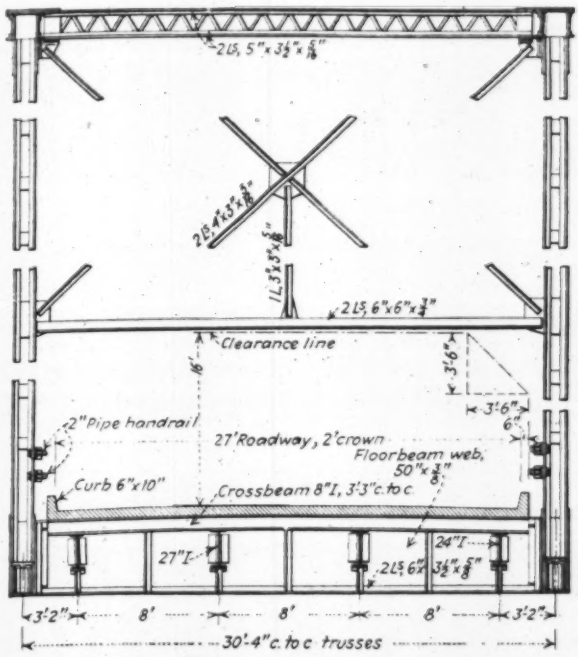


FIG. 2—CROSS-SECTION OF BRIDGE

truss is of course singly an indeterminate structure. In making the stress analysis, the end reaction was taken as the redundant, and its influence line (also the "elastic curve" for the truss) was constructed (see Fig. 3). For the preliminary design, the ordinates to the influence line were taken from a previous design of similar character with the same number of panels. The final revised values were calculated by the method of elastic weights from the sections determined in the preliminary design. A second revision was unnecessary. It is of interest to note that the final value of the end reaction, for a uniform load over the entire span, by the elastic weight method, was found to be 2.3 per cent smaller than the corresponding value for a two-span continuous truss with constant moment of inertia.

The dead load distribution curve for the truss as designed is shown in Fig. 3. The end reaction for the dead load so distributed was found to be 5 per cent less than for the same total uniformly distributed over both spans. On account of the large dead-load to live-load ratio and the fact that many of the members carrying smaller stresses were determined by conditions other than maximum unit stress (such as maximum $l \div r$, minimum thickness of material, etc.), the effect of reversal of stress on the design was negligible, as determined by applying the usual formula of designing stress equals the maximum plus half the minimum. In no single case did the stress reversal materially change the design of the section.

The wind stresses in the bottom laterals were calculated, assuming the lateral system as a two-span continuous truss with constant moment of inertia. The wind stresses did not govern the design of any member of the bottom chord. The secondary stresses at critical points were investigated, and for design purposes an excess unit stress of 50 per cent of the dead, live and impact loads was allowed. Computations showed that the extreme secondaries were within this limit. This result was in a considerable measure due to the use of members with a low ratio of $l \div r$, and to the use of simple rather than subdivided paneling.

The 900-ft. truss is riveted throughout. Special care was taken in the design of the large gusset plates at the main joints, and stays were provided in all cases where there was any question as to the stability against buckling of the unsupported plate. Figs. 2, 3 and 4 show the stresses and sections for the continuous truss. The floor consists of a 6¼-in. slab of reinforced concrete on

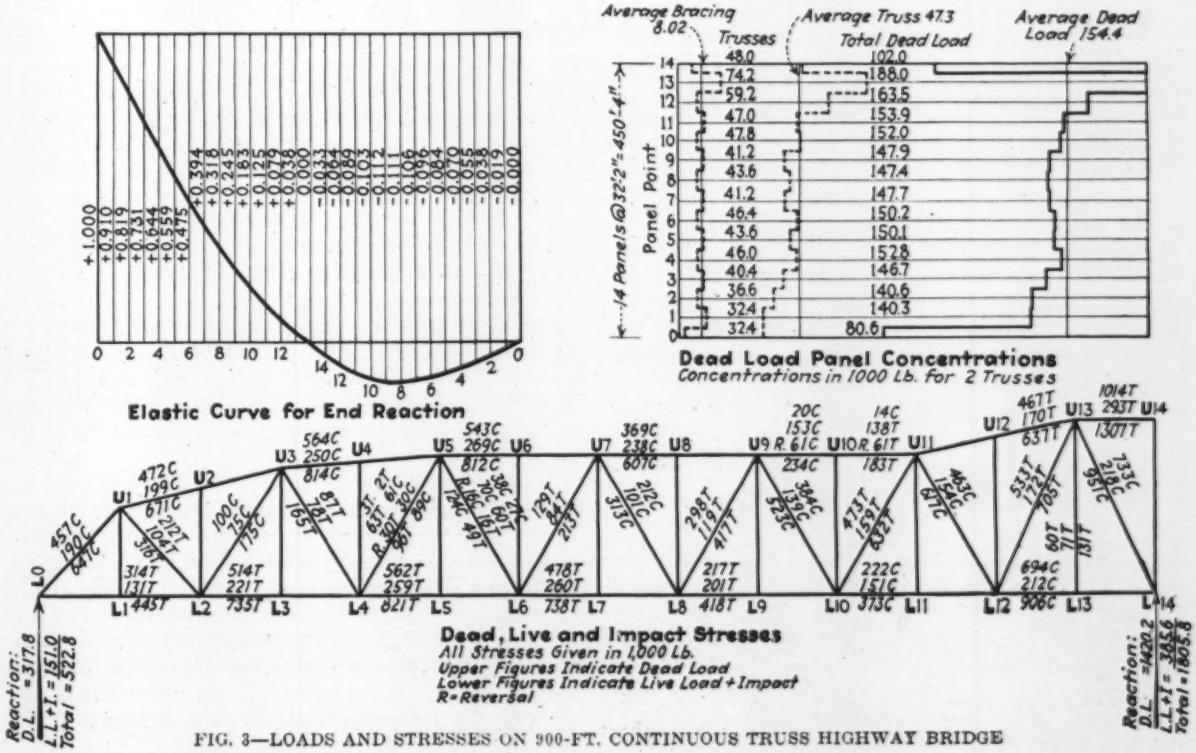

Elastic Curve for End Reaction
Average Bracing 8.02
Average Truss 47.3
Total Dead Load
Average Dead Load 154.4
Trusses
Panel Point
14 Panels @ 32'-2" = 450'-4"
Dead Load Panel Concentrations
Concentrations in 1000 Lb. for 2 Trusses
Dead, Live and Impact Stresses
All Stresses Given in 1,000 Lb.
Upper Figures Indicate Dead Load
Lower Figures Indicate Live Load + Impact
R = Reversal
Reaction: D.L. = 317.8 L.L.+I. = 151.0 Total = 522.8
Reaction: D.L. = 1420.2 L.L.+I. = 385.6 Total = 1805.8

FIG. 3—LOADS AND STRESSES ON 900-FT. CONTINUOUS TRUSS HIGHWAY BRIDGE

transverse members consisting of 8-in. I-beams curved to the designed crown. These beams, 3 ft. 3 in. c. to c., are carried on 24-in. and 27-in. I-beam stringers which are framed between the floor beams and are approximately radial to the crown of the road surface.

Personnel—This bridge was designed and is being built under the direction of the Missouri State Highway Department, T. H. Cutler, chief engineer. The design was made in the bureau of bridges under the direction of the writer, who was at that time chief of the bureau. Robert Sailer was principal designing engineer. The construction work is being carried out under the direction of N. R. Sack, bridge engineer of the Missouri State Highway Department, with H. A. Anderson as resident engineer.

The Mount Vernon Bridge Company, Mount Vernon, Ohio, has the contract for the continuous spans, and the Missouri Valley Bridge & Iron Company, Leavenworth, Kan., is contractor for the substructure. Oscar Schmidt, St. Joseph, Mo., has the contract for approaches. The completed bridge is expected to cost in the neighborhood of $600,000.

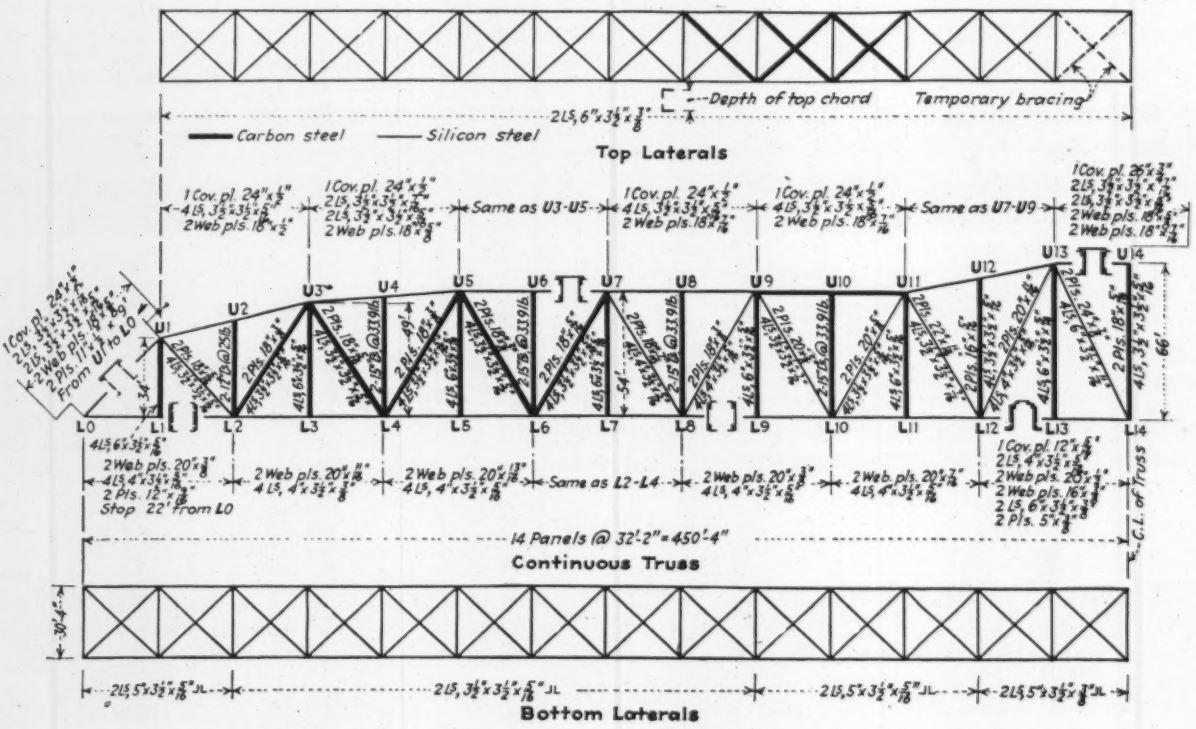


FIG. 4—CONSTRUCTION OF CONTINUOUS TRUSS SPAN

"Reasonable Use" of Water Awaits Adjudication in California

ON NOV. 6 the people of California by popular vote ratified a constitutional amendment that had been passed by the last legislature revising the water law of the state, particularly in the matter of riparian rights. A portion of the new law in which the purpose is outlined reads as follows:

"Because of the conditions prevailing in this state the general welfare requires that the water resources of the state be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interests of the people and for the public welfare. The right to water or to the use or flow of water in or from any natural stream or watercourse in this state is and shall be limited to such water as shall be reasonably required for the beneficial use to be served, and such right does not and shall not extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of water."

The amendment is the outgrowth of the Herminghaus decision affecting water rights (*Engineering News-Record*, Feb. 3, 1927, p. 204) and is an effort on the part of the state to protect the interests of the people as a whole with a view to the conservation of waters in the public interest. The question of the constitutionality of the new law has been raised and already one court decision (Calaveras County Superior Court, Collier vs. Merced Irrigation District) has implied that the amendment is invalid. That is, the court held that the state could not authorize the riparian right of any individual to be taken from him without compensating that individual for his loss.

It is believed, therefore, that the effect of the new amendment will depend to a large extent upon the construction which the court gives to the word "reasonable" in the phrase "reasonable use of water" and "reasonable method of diversion and use." There is doubt, too, as to whether, in the case where unreasonable methods of use now existent, such as natural overflow, have some monetary value to the riparian owner, the constitutionality of the act can be sustained. In other words, until the case has been adjudicated it is uncertain just what the effect of the new legislation will be.

Digesting Sewage Sludge at Its Optimum pH and Temperature

Laboratory Experiments Indicate That Baltimore Sludge Digests Within 30 Days When Kept at a Temperature of 28 Deg. C. With a pH Varying From 6.8 to 7.6

By C. E. Keefer and Herman Kratz, Jr.

Engineer of Sewage Disposal, and Junior Chemist, Respectively, Baltimore Sewage-Works, Bureau of Sewers, Baltimore, Md.

THE problems connected with the digestion of sewage sludge are commanding the attention of the chemist and the engineer more than at any other time in the history of sewage disposal. That the pH of sludge, together with its temperature, plays a major part in the speed of digestion is a fact which is firmly established. The researches of Rudolfs, Fair and others have indicated that a normal sludge should be kept at a pH somewhat about 7.0 in order to obtain the most rapid digestion. Furthermore, Rudolfs has shown that the most desirable temperature for intensive digestion is from 80 to 85 deg. F. (about 27 to 30 deg. C.). Data, however, are lacking as to the optimum pH at which sludge should be kept when the above-mentioned temperatures are maintained. To help supply this lack two duplicate sets of laboratory experiments were conducted at the Baltimore sewage-works. As the conclusions reached from both groups of experiments are the same, the results of only one are described. The work indicates that when Baltimore sludge is kept at a temperature of 28 deg. C. (about 82 deg. F.) and at a reaction near neutrality, the material is about 90 per cent digested within 30 days, as judged by the reduction in volatile solids and the volume of gas evolved. At the end of this time the sludge is well suited for air drying on sand beds. An additional fifteen days is needed to complete the digestion process. Provision to retain the material for this added time may be advisable where it is advantageous to collect and use as much gas as possible.

Method of Procedure—Raw sludge was obtained from the bottom of one of the dewatered primary sedimentation tanks at the Baltimore sewage-works, and ripe material was drawn from a separate sludge-digestion tank. The former sludge was about one week and the latter several months old. The two materials were analyzed, then thoroughly mixed in the proportions given. As indicated, approximately 10,890 grams of the mixture was put in each of seven 5-gal. bottles. Throughout the experiment the sludge in six of the containers was kept at as constant a reaction as possible. The pH, however, in each bottle was different. These values were 6.4, 6.8, 7.2, 7.6, 8.0 and 8.4. The sludge in the remaining bottle was used for comparative purposes and consequently the reaction was not controlled. The pH of the sludge was regulated by a solution of lime or undiluted hydrochloric acid. The quantity of lime added at any one time varied from 10 to 50 grams, and the quantity of acid from 20 to 60 c.c. All of the sludge was incubated at 28 deg. C. ± 1 deg. (about 82 deg. F.). The experiment, which lasted 78 days, was begun on March 2, 1928, and was completed on May 18, 1928. Samples of sludge were withdrawn from the bottom of each bottle twice a week from March 2 until April 24, and thereafter only once a week. Each of these samples weighed from 60 to 65 grams.

The gas, produced by the digestion of the sludge, flowed through glass tubes into a number of carboys, which were filled with water saturated with carbon dioxide. As the gas displaced the water, the volume of the former was readily determined. No corrections were made to determine the volume of gas at a uniform temperature and pressure, as there would be little change in the results. In each instance, however, the quantity of the gas was measured at atmospheric pressure. The volume and the analysis of the gas were determined daily except on Sundays and holidays.

Results—The results of this experiment are shown by the accompanying diagrams. The reduction in volatile solids of the "control," together with the sludges kept at a pH of 6.4, 6.8 and 8.4, was appreciable during the first ten days. After that time, however, the reduction was slight except for the material kept at 6.8, in which case the sludge contained 56 per cent volatile solids at the end of the experiment. With reference to the sludges kept at a pH of 7.2, 7.6 and 8.0, the decrease in volatile matter was rapid during the first 35 days, after which time the digestion was slow, as most of the material had decomposed.

CHARACTERISTICS AND QUANTITIES OF UNDIGESTED AND DIGESTED SLUDGE USED

	Weight, Grams	Moisture, Per Cent	pH	Solids — Total	Solids — Volatile — Weight, Grams	Solids — Volatile — Per Cent
Undigested sludge	7,257	90.18	5.2	712.6	573.1	80.42
Digested sludge	3,629	84.50	7.1	562.5	286.9	51.5
Ratio of undigested to digested material	2	.....	...	1.27	2	.....

One point of interest is that at the end of the experiment there were more volatile solids in the sludge kept at a pH of 6.8 than in the sludges maintained at 7.2, 7.6 and 8.0. The former material had all the appearance and characteristics of being well digested. Furthermore, the quantities of methane and total gas produced per gram of fresh volatile solids were comparable with the gases from the latter sludges. One possible interpretation of these results is that gasification is as great at 6.8 as at 7.2, 7.6 and 8.0, but that there is less liquefaction of solids.

The quantities of total gas produced per 24 hours per gram of total volatile solids are also shown. The highest daily rates of production were from the 6.8 and the 7.2 materials. The wide fluctuations in the quantities of gas are due in part to the release of hydrogen sulphide shortly after the additions of acid and to the absorption of carbon dioxide by the lime. With the exception of the 8.0 sludge, the production of gas had nearly ceased at the end of 35 days. This period corresponds with the time when the reduction in volatile solids had about ended.

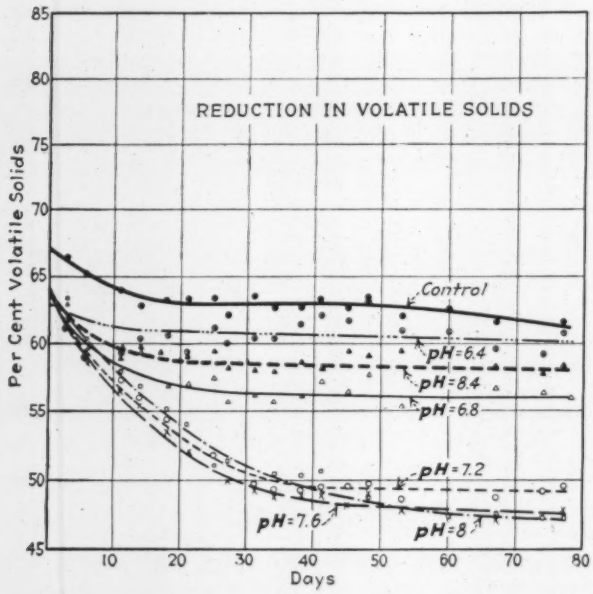
The quantities of methane and total gas production per gram of fresh volatile solids are of special interest. The greatest volume of gas was collected from the 6.8 sludge and the least from the 8.4 material. The "control" generated only slightly more gas than the latter sludge. The major portion of the gas from the 6.8, 7.2 and 7.6 materials was evolved during the first 30 to 35 days. The gas produced from the sludge kept at 8.0 should be noted. The rate of production, which is equivalent to the slope of the curve, was uniform for the first 25 days. From then until about the fiftieth day the rate was considerably less.

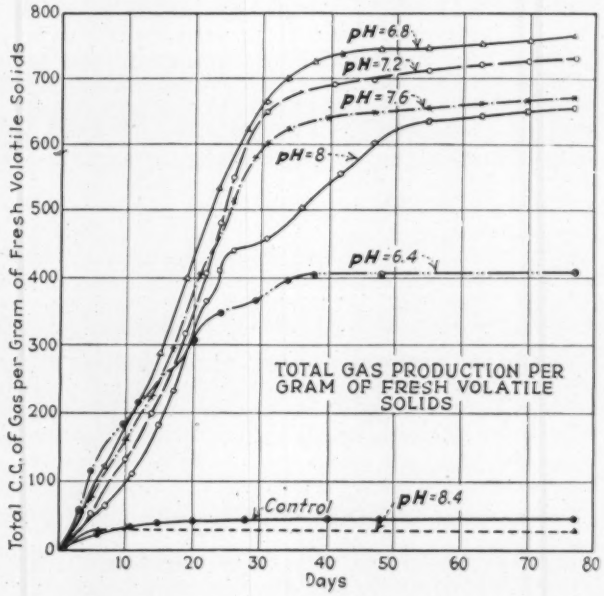
Total methane production is also shown in one of the diagrams. The sludge kept at a pH of 6.4 gave off as much of this gas during the first fifteen or twenty days as the other sludges with higher pH values. From then until the thirty-fifth day there was some gasification, although it was slight. During the remainder of the experiment there was no further digestion. These results seem to indicate that a pH of 6.4 is a suitable environment for those organisms that break down the substances which are digested first. This environment, however, is not adapted to other organisms which are responsible for the further digestion of the organic material and whose life processes function best at a higher pH.

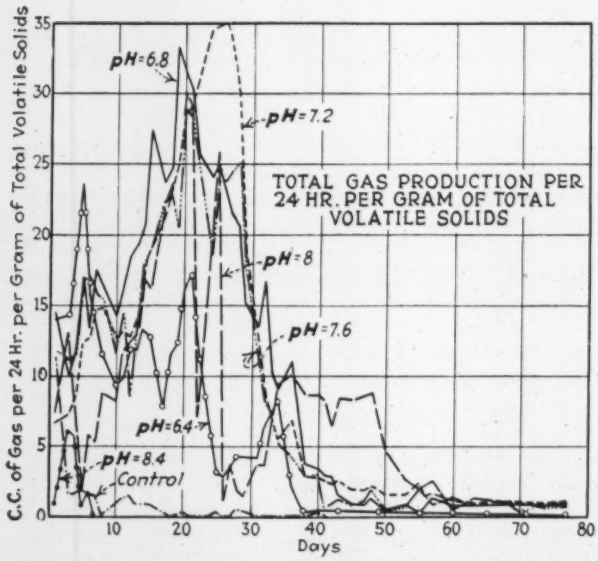
The quantities of methane evolved from the 6.8, 7.2, 7.6 and 8.0 sludge were about the same. The sludge with a pH of 7.2 produced slightly more of this gas did than the other materials. Practically no methane was formed from the "control" or from the 8.4 sludge. There was little evidence of biological activity in this latter material, due to its being necessary to add 120 grams of lime during the first week of the experiment. Although there was practically no gasification from the 8.4 sludge, there was some little liquefaction, as it is apparent from the decrease in volatile solids as indicated.

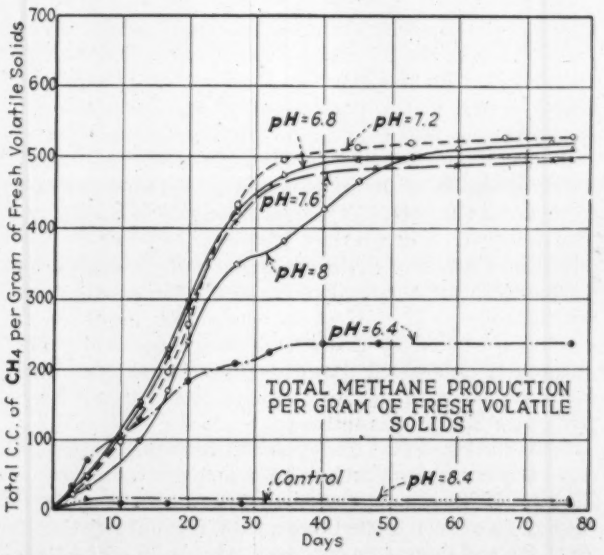
At the end of 163 days the "control" was still far from digested. Its pH was 5.0, and it contained 61.3 per cent volatile material and 89.7 per cent moisture.

Physical Characteristics of Sludges—The sludge used









RELATION OF VARIOUS pH VALUES TO REDUCTION IN VOLATILE SOLIDS, TO TOTAL GAS PRODUCTION AND TO METHANE PRODUCTION

In all cases the incubation temperature was 28 deg. C., or about 82 deg. F.

for seeding purposes was well digested. It was black and had a tarry-methane odor. The fresh sludge had a yellow-brown color and a fecal odor. Throughout the experiment the sludge kept at a pH of 6.4 had the odor of hydrogen sulphide, caused by the use of hydrochloric acid. This odor would prohibit the drying of such material in large quantities on sludge beds. At the beginning of the investigation a fecal odor was given off from the sludge kept at a pH of 6.8, 7.2 and 7.6. This odor had entirely disappeared at the end of 35 days. The 8.0 and especially the 8.4 sludge produced a disagreeable odor similar to that from a pile of old oyster shells.

All of the sludges, except the one kept at a pH of 8.4 became black within 10 to 45 days. Due to the addition of hydrochloric acid, the 6.4 and 6.8 materials were the first to acquire this color. The 7.2 and 7.6 sludge became black in 40 days, and the 8.0 sludge in 45 days.

The solids in the sludge with a pH of 7.2 were finer than in the other sludges. Moreover, this material separated from its water more readily. There was little to choose from between the 6.8 and 7.2 sludges except that the solids in the former were slightly coarser. The material kept at 6.4 and 7.6 were inferior to any of the former sludges when judged by the ease with which solids and liquid separated. The 8.0 sludge was not so good as the other sludges with a smaller hydrogen-ion concentration. The sludge maintained at a pH of 8.4 showed the least variation in physical characteristics. This material changed but little during the 78-day incubation period.

Conclusions—Until the results obtained from small-scale laboratory experiments have been more extensively checked in the field, the conclusions formulated from such work should be made with caution. The investigations, in so far as they pertain to Baltimore sludge, seem to indicate: (1) Sludge kept at a temperature of 28 deg. C. and at a pH ranging from 6.8 to 7.6 will digest sufficiently well within 30 days to dry on sludge beds. (2) The quantity of methane generated will be about 450 c.c. per gram of fresh volatile solids at the end of 30 days. By storing the sludge for another twenty days this volume will be increased to 500 c.c. (3) If the pH of Baltimore sludge is not adjusted either by chemical means or by having sufficiently large quantities of ripe material present, digestion is likely to be greatly retarded.

It should be noted that the undigested sludge used in the experiment was about a week old. If this material had been only a few hours old when it was mixed with the digested solids, it is possible that even more rapid digestion would have occurred.

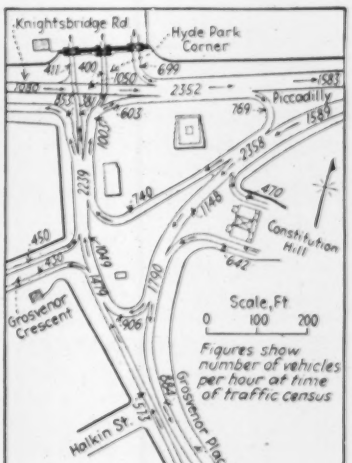
The Baltimore sewage-works are under the general supervision of C. F. Goob, chief engineer of the Department of Public Works, and M. J. Ruark, sewerage engineer.

Roundabout System of Traffic at Certain London Squares

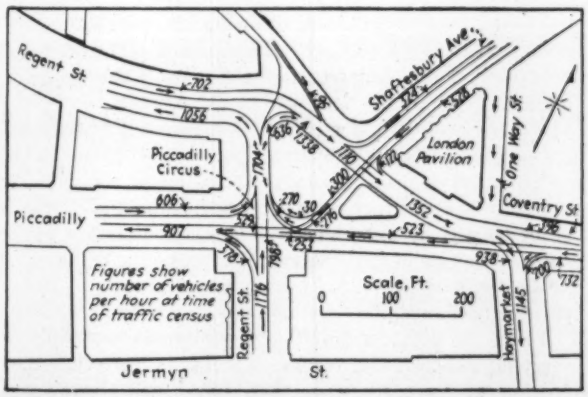
ANNOUNCEMENT by the U. S. Bureau of Public Roads that it proposes to inaugurate and study what in London is called the roundabout scheme of traffic at important irregular intersections prompts the reproduction of the arrangement at three famous points. After the adoption of the system in 1926 some rounding of curb corners was needed along with arrangement of one or two awkwardly placed refuges.

This system of circular movement was first used at Columbus Circle, New York City, where it was inaugurated in 1903. Four years later it was put into effect around the Arc de Triomph, Paris. The method of routing traffic at Columbus Circle never has been entirely successful due to irregularities of movement which were not anticipated when the system was laid out.

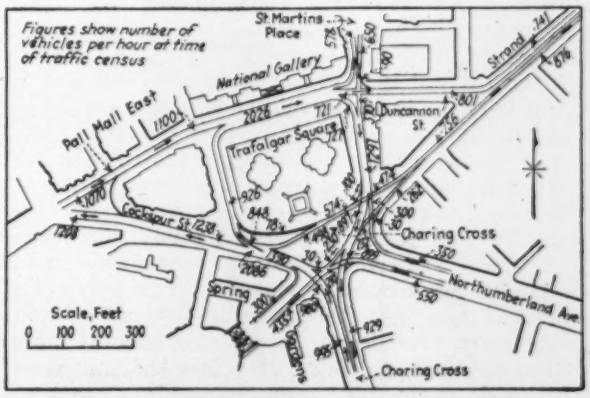
An adequate supply of legible and intelligible signs and white lines is an essential feature. The diagrams are a result of an analysis of the peak traffic load. At Hyde Park Corner 28 traffic intersections were reduced to one. Eighteen intersections at Picadilly Circus were reduced to five and at Trafalgar Square 40 were reduced to seven. A freer and more continuous and regular movement of traffic was effected as well as less onerous and exacting work on the part of the police.



ARRANGEMENT OF TRAFFIC AT HYDE PARK CORNER



ROUNDABOUT TRAFFIC ROUTING AT PICADILLY CIRCUS, LONDON



TRAFALGAR SQUARE INTERSECTIONS REDUCED FROM 40 TO 7

Illustrations are from abstract of Second Annual Report of the London and Home Traffic Advisory Committee for year 1926-27 in Bulletin of Permanent International Association of Road Congresses.

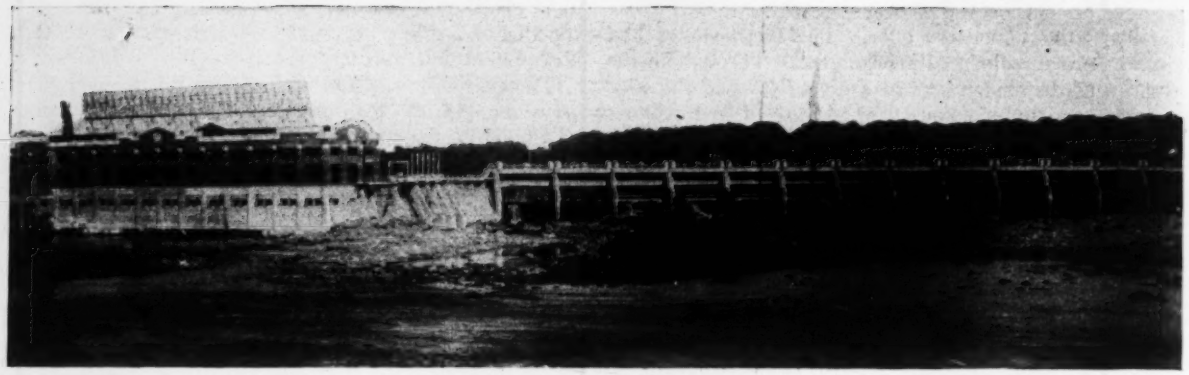


Fig. 1—Chippewa Falls Hydro-Electric Plant, Downstream Side

Second Hydro-Electric Plant on Chippewa River

Located at Chippewa Falls, 2½ Miles Below Wissota Dam—Turbines of Propeller Type With Adjustable Vanes—Spillway Dam Has Tainter Gates 40 Ft. Long

IN THE new 21,600-kw. hydro-electric plant on the Chippewa River near Chippewa Falls, Wis., the principal features of technical interest are the large propeller-type adjustable-vane waterwheels, the unusually large tainter gates on the spillway and the fact that the plant works practically on the tailwater and overflow from the larger 31,680-kw. Wissota plant, 2 miles up the river. Construction work carried on during severe winter is interesting also, but is not unusual. As a public utility plant, it is of interest as being the latest addition to a group of more than twenty large and small interconnected water-power plants which aggregate approximately 130,000 kw. This group, together with steam plants of 220,000-kw. capacity, forms the system of the Northern States Power Company, Minneapolis, Minn., which serves a total of 568 cities and towns in the territory centering around Minneapolis and St. Paul.

The level of headwater at the Chippewa Falls dam is approximately that of the tailwater at Wissota and there is practically no pondage or reserve storage in the 2-mile stretch of river between the two dams. Ice conditions are not expected to be troublesome. The water discharged from Wissota will be so warm, due to the large storage and the ice cover over the reservoir, that it is assumed there will be little or no ice in the reservoir of the Chippewa Falls plant. The maximum water capacity of the plant is about 10,000 sec.-ft. Normally, the operating head on the turbines will be 29.6 ft.

The riverbed is in granite rock, with little cover of mud or sand. From preliminary investigations and borings it was thought that this would be solid rock. When construction was begun, however, it proved to be badly shattered, with cleavage planes in all directions, so that the over-break was large. Considerable excavation and concrete were required, therefore, beyond the amounts estimated. The cutoff trench was carried deep into the rock and this rock was thoroughly grouted to a depth of 15 or 20 ft. below the bottom of the trench. Inclined bore holes were driven, in order to intersect various cleavage planes, and these, after they had been washed out with water jets, were thoroughly grouted with cement under 100-lb. pressure at the pump.

In plan the dam forms an angle, extending as a flat V across the river, in order to follow a high ridge of the rock surface. One leg is the power-house section, the other the spillway section. In a short stretch at the apex are three sluice gates 8x12 ft., for lowering or drawing down the water level, and a single trash chute 20 ft. wide. The panel gate at this last opening drops down into a chamber beneath the sill, so as to leave an unobstructed channel for drift and floating débris.

No log-way or chute is provided, since logging has practically ceased on this river, while a floating timber boom protects the forebay from drift and occasional logs. There is no fishway or fish ladder in the dam, this feature being not now required by the Wisconsin Conservation Commission. It has been found that fish ladders are not used so much by game fish as by the less desirable species, which thus invade the upper waters. Fishing and hunting interests have requested, therefore, that this feature be eliminated in new dams.

The spillway portion of the dam is of ogee section, with a maximum height of about 18 ft. and base width of about 30 ft., so that a rounded crest and a flat lower curve give free flow for the falling water. The upstream face is carried down as a 3-ft. cutoff wall into solid rock, while at the top it has a cantilever shelf or extension to form a sill for the emergency gates in front of the tainter gates which surmount the crest. A drainage tunnel is carried through the dam and has 4-in. drain holes extending down to a longitudinal drain of broken stone which is laid on the rock surface. This pile of stone was covered with a dry concrete to hold it in place while the mass concrete of the dam was placed over it. Any leakage at the heel, if under heavy pressure, will find its way up into the drainage tunnel.

No apron or protection is provided below the dam, the necessity and character of such protection being left to be developed by experience. The original rapids in the river at this point had caused little erosion. While some protection may be needed eventually, it is not a matter of present necessity.

From the north end of the power house extends a fill carrying two railroad tracks, and this is protected from erosion by an earth wing dam faced with heavy rock revetment. An earthfill with similar revetment extends from the south end of the spillway dam to high ground.

A tailrace channel 270 ft. wide is excavated just below

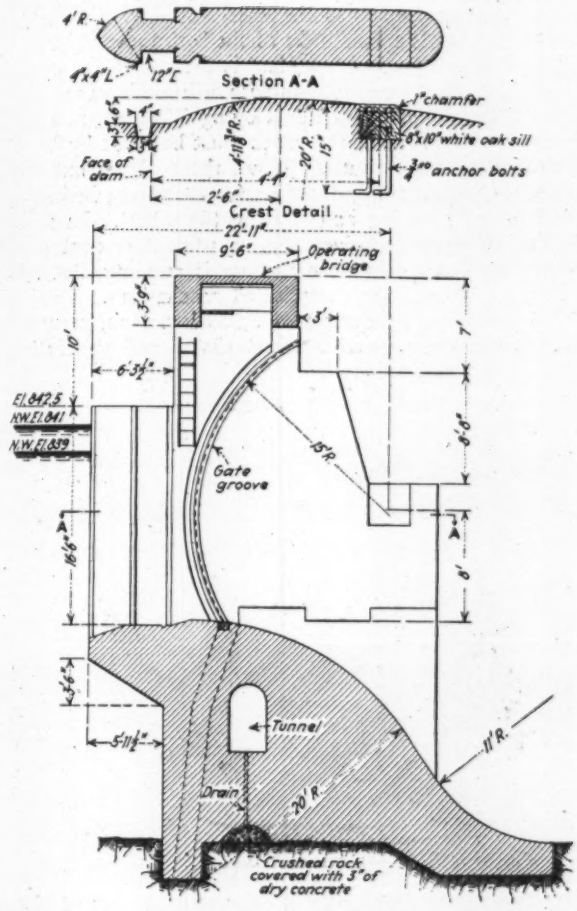


FIG. 2—SPILLWAY DAM

the power house to give free discharge from the draft tubes and tail pits. Along the north side of this channel is a line of rock-filled timber cribbing to prevent eddies and erosion at the mouth of Duncan Creek, which enters the river at this point.

Along the crest of the spillway dam is a row of thirteen tainter gates of unusual size, each 40 ft. long and 13½ ft. deep, having their tops normally 6 in. above the flow line. These gates have rubber seals at the sides, moving in grooves formed in the piers, and when lowered they seat on 8x10-in. oak sills embedded in the crest of the dam. In view of the great length of these gates, it would be difficult if not impracticable to place ordinary stop logs to shut off a gate for inspection or repair. A 40-ft. steel frame is provided, therefore, which can be handled by a derrick and lowered into guide grooves in the piers, stop logs being then placed to fill the panels in this frame or emergency gate. The flow capacity of the spillway is 90,000 sec.-ft. for normal pond level, which may be increased to 110,000 sec.-ft. by raising this level 2 ft.

These large tainter gates are equipped for both motor and hand operation by means of machinery located on the operating bridge carried by the piers. For each gate there is a line shaft of practically the same length as the gate. The motor and a speed-reduction unit are located at the middle, while the ends of the shaft are provided with worm gears driving the drums which carry the operating chains attached to the gate. The motors of the two gates nearest the power house are arranged also for remote control from the station switchboard, in order to provide for promptly spilling or releasing the excess water in case of loss of load on the plant or the necessity of quickly shutting down one or more of the power units.

This remote control arrangement is introduced also for the purpose of releasing surges of water that may result from rapid opening of the spillway on the Wissota dam. These gates, of the Stauwerke type, are found to be lacking in sensitiveness, so that they sometimes open more than is necessary to take care of the increased flow and therefore for a short time discharge considerably more water than is desired. In the same way they do not rise or close until after the head has dropped. These properties of the Stauwerke gates were noted in *Engineering News-Record* of Sept. 23, 1920, p. 589. It is not expected that there will be much necessity for quick action by remote control of the tainter gates at Chippewa Falls, since any sudden rush of water at Wissota is likely to be flattened out in its half-hour of travel down the river to Chippewa Falls.

At the intakes are the usual trash racks, the bars in this case being vertical and spaced 5 in. c. to c. A power

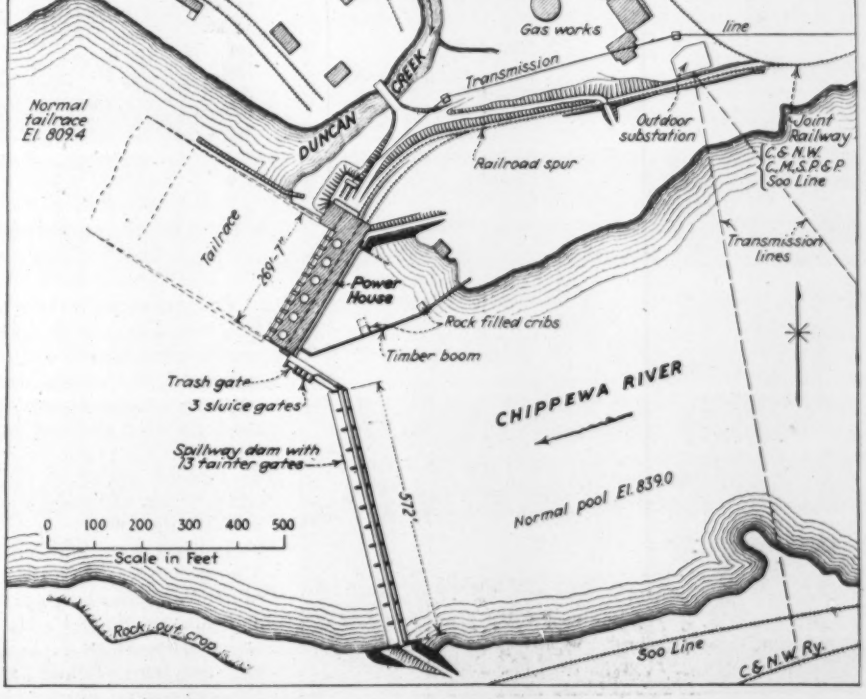


FIG. 3—GENERAL PLAN OF HYDRO-ELECTRIC PLANT, CHIPPEWA FALLS, WIS.

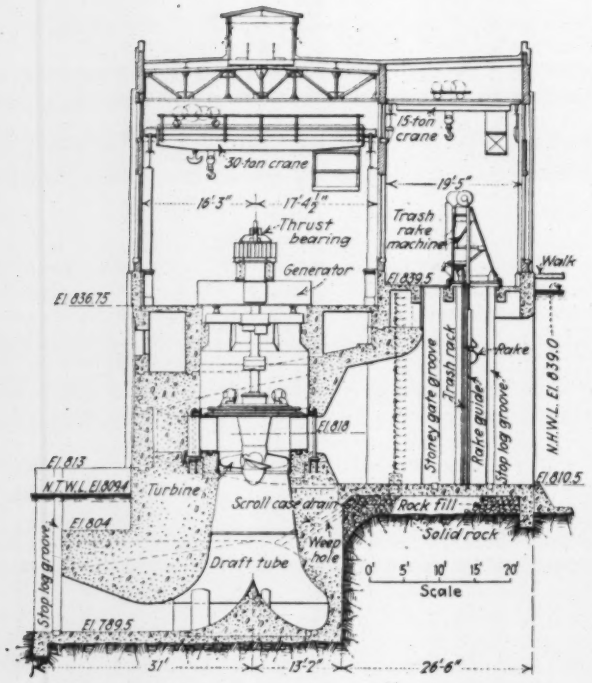


FIG. 4—CROSS-SECTION THROUGH POWER HOUSE

rake for clearing the racks moves in guides in the piers and is handled by a motor hoist on a carriage traveling on rails in the floor of the gate chamber. Most of the floating trash, however, will be taken out at the Wissota dam or kept away from the forebay by the timber boom. The covered gatehouse, which will be heated during cold weather, will reduce the danger of ice troubles at the trash rack. This structure has a 15-ton overhead traveling crane for handling the Stoney type head gates. Space is provided at the land end of the forebay for storing the head gates and stop logs which are used for closing the intakes.

Short flaring rectangular intakes open into the scroll case, which is of the semi-scroll type consisting of two curved passages leading to the wheel chamber. Below the wheel chamber is a draft tube of the hydraucone type.

A notable feature of this plant is the use of six of the largest propeller-type turbines with adjustable vanes ever built in this country, each developing 5,000 hp. at 138.5 r.p.m. Adjustment of the vanes must be made by hand, which necessitates shutting down the turbine, but this operation requires only three or four minutes, including the time of stopping and starting the wheel. In some similar European turbines the adjustment is controlled by the governor while the turbine is running, but this arrangement involves complicated mechanism.

There are six generators of 3,600 kw. each, mounted directly on the respective wheel shafts and generating current at 4,000 volts. The machines are spaced 45 ft. c. to c. Current is delivered to a substation from which

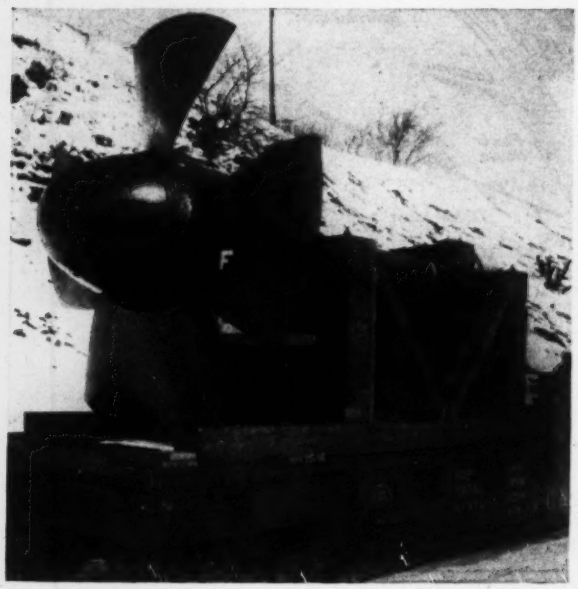


FIG. 5—RUNNER OF ADJUSTABLE-VANE TURBINE

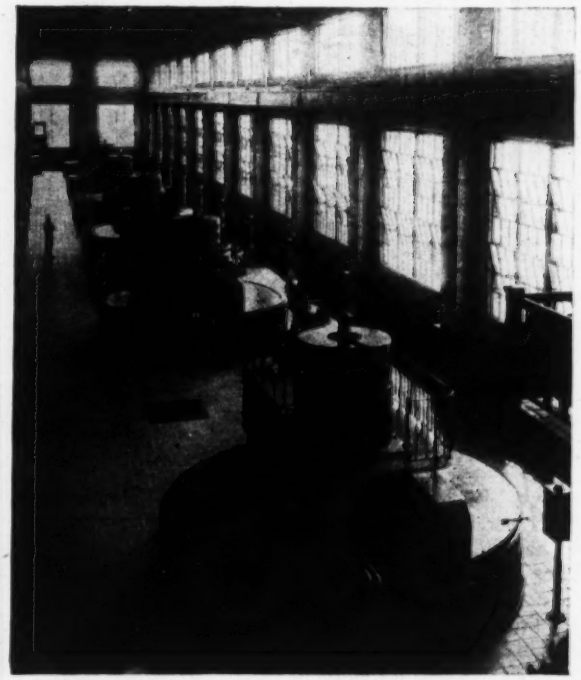


FIG. 6—GENERATOR ROOM OF POWER PLANT AT CHIPPEWA FALLS

a 110,000-volt transmission line 2½ miles long extends to the Wissota electric switching yard, from which point two 110,000-volt lines run to Minneapolis and St. Paul.

The power-house superstructure, 320x52 ft., is a steel-frame building, with walls of red hollow tile having a rough exterior surface.

Construction work was started in September, 1927, and was to be completed by Sept. 1, 1928, but in view of the increasing demand for power the work was speeded up so that the plant was put in service on June 15, 1928, 2½ months ahead of the schedule. Particulars of the construction methods will be given in a later article.

Both the design and construction of the Chippewa Falls plant were handled by the Byllesby Engineering & Management Corporation, Chicago, under the direction of H. W. Fuller, vice-president in charge of engineering and construction; F. H. Lane, manager of engineering and construction; J. William Link, hydraulic engineer, and Stephen Wehner, assistant engineer; with W. T. Walker general superintendent of construction and W. H. MacArthur resident superintendent of construction.

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

Discharge Through Aswan Dam Sluices

REVIEWED BY ROBERT E. HORTON
Consulting Hydraulic Engineer, Albany, N. Y.

THE MEASUREMENT OF THE DISCHARGE OF THE NILE Through the Sluices of the Aswan Dam. Final Conclusions and Tables of Results—By H. E. Hurst, D.Sc., Director-General, Physical Department, and D. A. F. Watt, Resident Engineer, Aswan Reservoir, Physical Department Paper No. 24. Cairo, Egypt: Publications Office, Government Press. Boards, cloth back; 7x10 in.; pp. 44 (mostly tables); 4 plates. 10 piasters (50 cents) in Egypt.

The first 8 pp. of this monograph present a brief summary of results of twenty years' experiments for the determination of discharge through the sluices of the Aswan dam. The remaining 36 pp. of text are filled with tables giving the discharge through sluices for different reservoir levels and sluice openings. Four plates show the tank used for volumetric calibration of sluices, details of the two principal types of sluices and a diagram of experimental discharge coefficients and the resulting coefficient for various heights of sluice-gate opening. The experiments are of general interest both because of the methods used and because of the magnitude of the quantities involved. For details of the experimental work the reader is referred to three recent papers published in the *Proceedings* of the Institution of Civil Engineers.

It is stated in the Preface that the results briefly summarized in the paper are based on 250 volumetric experiments, 730 experiments with special current meters in the sluices, 2,500 experiments with models and 1,130 measurements of discharge of the Nile by the open-section current-meter method. In determining the coefficient of discharge of the sluices in the volumetric measurements, the basin constructed below the dam to act as a water-cushion was utilized as a tank, this basin having a capacity of 22,000 cu.m. This work represents direct volumetric calibration of hydraulic structures on an unusually large scale. The book under review is a practical manual for computing discharge of the Aswan dam and only meager average results of the experiments are given. It is unfortunate that so extensive a series of large-scale hydraulic experiments have not been brought together in printed form, especially as reliable data for calculating discharge through large sluices are unfortunately meager.

The sluices are rectangular in cross-section, with flaring entrance at the sides and top. It is stated that there is no appreciable backwater effect and that the discharge takes place virtually the same as free flow into the air. The final formula obtained is

$$Q = cA\sqrt{2g\ (H - F)}$$

H being the depth or head on the sill of the sluice. If H is measured in the same way, the ordinary formula for discharge through an orifice takes the form

$$Q = cA\sqrt{2g\ (H - \tfrac{1}{2}h)}$$

where h is the height of the sluice-gate opening. The value of F in the Aswan formula is not, however, one-half the height of the sluice-gate opening, but is given for most conditions as $0.8h$. The cause of this departure from the ordinary aperture formula is not stated. It is, of course, well known that the ordinary aperture formula gives somewhat too large results when $h > \frac{1}{2}H$. This fact probably only in part explains the departure from the ordinary orifice formula. Probably this departure is due to some extent to the fact that the bottom of the sluices extends horizontally upstream and downstream from the gate sill.

Experiments were also made on free flow through the sluices, the sill of the sluice acting as a broad-crested weir with rounded upstream corners. The average coefficient obtained was 3.06, which is gratifyingly close to the theoretical coefficient in this case, which is 3.09.

As compared with volumetric measurements, excellent results were obtained by current meters for low discharges, but for floods the discharge measured by current meters was found to be excessive by 5 to 9 per cent. Interesting comparisons were made between the discharge through scale models and full-scale sluices. The two discharges are related through the equation $Q = n^{5/2}q$ where q is the discharge of a scale model, n the scale ratio, and Q the discharge for the full-size sluice or prototype. This formula merely expresses the relation that for all linear dimensions reduced by the same ratio, including the head, the discharge coefficient for the sluice is the same for the model as for the prototype. Details of these scale model experiments, as of all others, must be sought in the papers of the Institution of Civil Engineers, referred to.

How to Cope with Construction in Winter

REVIEWED BY A. P. GREENSFELDER
President, Fruin-Colnon Contracting Company, St. Louis, Mo.

WINTER CONSTRUCTION METHODS: Processes and Plant Employed in Prosecuting Construction Operations in Cold Weather—By Charles S. Hill, Associate Editor, *Engineering News-Record*. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 180; 67 line cuts and halftones. $3.

Constructors are now rapidly coming to realize that "winter work is worthwhile" and that it is "custom, not climate," which retards continuous construction throughout the year. There are a few, however, who are still rather fearful and timorous about undertaking work of this kind and lack knowledge relative to the necessary procedure attendant thereto. Also there are times when all who do undertake winter construction would like a handy reference of concrete examples and precedents to follow in regard to the various phases of work in the cold season of the year. To all constructors, therefore, Mr. Hill's "Winter Construction Methods" is an invaluable aid and an admirable book to be consulted and used.

The book does not try to disguise the fact that there is an extra risk in undertaking winter construction, but in a logical and concise fashion the author shows how by taking precautionary measures one may do such work with confidence and success.

For many years the author has been interested in the problem of winter construction in the construction industry and has made exhaustive and painstaking economic studies of this subject. As a result the book contains much valuable information from authoritative sources. It not only deals with concrete examples of

construction projects where success has been achieved but with the problem of materials, construction equipment and the best methods of procedure when the temperature is at a low point. With the aid of charts, tables and interesting halftone views, the author further exemplifies his text and makes the book the most comprehensive study of this subject that I have yet read.

The book not only fills a long-desired want and need to the construction industry, but in my opinion would serve as an excellent textbook in civil engineering. It would imbue in the younger generation from the start an offensive and progressive attitude toward winter construction rather than a hostile and inactive one.

French Book on Water Power

UTILISATION DES FORCES HYDRAULIQUES — [ETUDES GÉNÉRALES ET INSTALLATIONS DE CHUTES] Par M. DeGove, Ingénieur en Chef des Ponts et Chaussées. Troisième Edition. Paris: Librairie de L'Enseignement Technique.

REVIEWED BY JOHN V. ZAHLEN
Supervising Engineer, Devils River Hydro-Electric Developments, Del Rio, Tex.

The author of this book writes in a clear, pleasant style, reflecting a thorough knowledge of his subject and great familiarity with what has been and is now being accomplished in the water-power field, not only in his own country but also in other countries, particularly in Scandinavia, Germany, Italy, Switzerland, Canada and the United States, where he has familiarized himself, on the ground, with the latest evolution and engineering practice in the field in question.

The author first gives a short history of water-power development from the bambu wheels of the Chinese to date. Distribution of available undeveloped and of developed water power in Europe and America is taken up and general descriptions of some of the newer developments are given. The second chapter deals with the hydrological and hydrographic features of the subject, and the general layouts of dams, canals and power houses. A number of European and American developments illustrate the text here as well as throughout the book. Next the author discusses more in detail the application the water-power resources to the use of man and the production of electrical energy.

Dams are given two chapters, the second being on "movable dams." Many notable gravity dams are given in cross-section with pertinent data as to year of construction, volume, foundations, operating experiences, etc. A table gives a number of arch dams of more than 50 meters (164 ft.) height and another table covers smaller dams. There are included the Coolidge multiple-dome dam now nearing completion, the Sherman Island dam and the Sourva dam in Lapland in northern Sweden. Hydraulic-fill dams are considered. Wasteways, spillway sections, spill tunnels and outlet structures of different types and other dam accessories are included.

The chapter on movable dams starts with roller dams, widely used for twenty years in Europe. The author states that one of these has recently been built to very large dimensions and has given excellent service under the most severe climatic conditions in northern latitudes. Stony-type gates of original and of improved, horizontally sectionalized types for great heights are shown as at Chancy-Pougny, Augst-Wyhlen, Lauffenburg, Faal and Jettenbach, on the Rhine. Tainter gates, as well as sector gates of the type used at American Falls, Melones and on other dams are shown in addition to the flood gate of modern bear-trap type widely used in Germany and now being included in the first hydro plants being built in Palestine. Butterfly and spherical valves of the Escher Wyss & Cie. type, gate valves, jalousie valves, as well as Larner-Johnson valves are described and illustrated.

Chapter VI deals with intake structures, illustrating the Fasalto, Barberinne, Davis Bridge and many other installations. Dufour and other types of sand traps, racks and screens of stationary and movable types, as well as rack-cleaning devices, are illustrated and discussed at some length. The next chapter goes into the subject of canals and intake channels, including their lining and protection. Flow and pressure tunnels in rock and soft ground are treated; flumes, flume and pipe trestles and siphons are described.

In Chapter VIII pipe lines and penstocks in steel concrete and wood are taken up, including treatment of forces acting upon them with reference to the theories of Allievi, Sparre, Camichel, Eydoux, Gariel and Michaud. Surge chambers of simple type, as well as of Johnson, Schoklitsch and other types, are briefly discussed. Penstock anchors and piers and expansion joints follow. Water measurement by venturi meters and by color, Gibson, Allen and calorimetric methods are briefly described. The concluding chapter contains extracts of laws and regulations for development of water power in France, with occasional references to similar statutes in other countries. There is a Bibliography.

The book is a distinctive contribution to French water-power literature and should be of value to any engineer interested in the developments in the field and who has a reading knowledge of the French language.

A Layman Writes on Engineering

THE STORY OF ENGINEERING IN AMERICA—By Chelsea Fraser. New York: Thomas Y. Crowell Co. Pictorial cloth; 6x8 in.; pp. 471; reproductions of 100 line drawings by the author and 18 photographs. $2.50 net.

The old adage, "A little knowledge is a dangerous thing," is upheld in the work of a layman presenting the romantic side of engineering. Although the author is to be commended for his ambitious attempt to cover the vast field of civil engineering in a single volume, he lets his enthusiasm and imagination overshadow actual facts and common sense. Roads, railroads, bridges, tunnels, dams, canals, buildings, lighthouses, mines and harbor improvement all come in for a share of his book.

Written in an interesting and popular style, the book will appeal to the non-technical reader, but for the engineer it is marred by numerous wild and inaccurate statements of fact and careless editing of both drawings and text matter. There is no excuse, save that of carelessness, of showing the length of the Moffat tunnel as 3,200 instead of 32,253 ft. in a table of tunnel lengths, or, in a sketch of the cross-section of the Shoshone dam, showing the bottom elevation as 504.46, a height of 328.4 ft. and the top as El. 5,373 ft. Steam-shovel operators will be astonished that they "accomplish as much work in a day with their big steel pet as 70,000 men with picks and shovels." Those who drove the Moffat tunnel, completed after a four-year struggle with soft ground requiring, in some cases, steel centering to withstand the pressures encountered, earnestly wish that the author's statement that the "bore 16 ft. wide and 20 ft. high has been gnawed through the base of a mountain of hardest rock" had been true. Again, in this same tunnel, air velocities from 10 to 14 m.p.h. provided by the ventilation system can hardly be classed as "65-mile gale."

Diagrams showing sections of the Brooklyn-Richmond railroad tunnel driven by the trench method and by the shield method are a bit previous, as this project is still under contemplation, if not abandoned. Cross-sections of Chicago's subways are likewise out of place. Building designers, in reading the book, will learn that in concrete column design "for the greatest strength the rods are laid crosswise," and that "by using an extra rich mixture of concrete for the columns in the lower stories, such as one part of cement to one part of sand and two parts of aggregate or gravel, and reinforcing the columns with both vertical steel bars and spiral steel hooping, they could design columns of wonderful strength which were no larger than incased structural steel columns used in similar positions."

These are only a few of the gross misstatements prevalent throughout the volume. Books presenting the story of engineering to the public are always desirable, but they should be based on actual facts, and not on imagination. It seems in this case that "the shoemaker should stick to his last."

British Text on Concrete Bridges

REVIEWED BY SEARCY B. SLACK
Bridge Engineer, State Highway Department of Georgia, East Point, Ga.

REINFORCED-CONCRETE BRIDGES: The Practical Design of Modern Reinforced-Concrete Bridges, Including Notes on Temperature and Shrinkage Effects—By W. L. Scott, M.Inst.C.E., Chief Engineer Considère Construction, Ltd., Assisted by C. W. J. Spicer. Second Edition, Enlarged. London: Crosby Lockwood & Son. Cloth; 6x9 in.; pp. 220; line cuts and halftones. 25s. in England.

The scope of this book and the author's reason for writing it are clearly set forth by the opening paragraph of the Preface: "Although in the large number of books available upon the subject of reinforced concrete, bridge work is in many cases dealt with, there appears to be no reference in English which is wholly devoted to these structures, or which covers the subject in a manner sufficiently comprehensive for the practical use of the engineer."

The introductory chapter, on the important subject of bridge types and general features of design, is rather brief and sketchy. From it one might infer that the test of reinforced-concrete bridges is their resistance to demolition by explosives or war methods. It is to be regretted that even a brief summary of the merits, demerits and general limitations of reinforced concrete as a material is entirely omitted.

The chapter on loadings affords an interesting comparison of the British, French and American systems of live loads. Unfortunately the American loadings referred to are entirely out of date. The loadings which have been adopted by the American Association of State Highway Officials and later by the American Society of Civil Engineers would more nearly represent practice in this country for the past few years in the highway field. A comparison of the live loadings shows that the British standard is very much heavier than either the standard French or that of the American Association of State Highway Officials; the 22-ton engine axle load and 50 per cent impact of the British standard loading represent units much heavier than any commercial highway loads in America. The French standard loading is practically the same as the American 15-ton truck (H-15) loading, which is probably the most generally used loading on highway work in the United States.

The methods of providing for temperature movements in girder bridges by reinforced-concrete rockers and by independent supporting columns in front of end abutments, described in the third chapter, are different from the simple sliding bearings generally used in America. The practice of placing steel reinforcing bars in flexure or bending, as is done in the reinforced-concrete rockers, has been questioned in discussions of several designs prepared in this country: the point being raised that steel bars repeatedly flexed would break and, further, that the steel passing through a moving joint between rocker and substructure or rocker and girder would be subject to corrosion.

The author has covered in a very clear and concise manner the general principles of design without attempting to go into exact theoretical discussions. As a whole, the methods outlined correspond very closely to general practice of design in this country, but there are several neat graphical and analytical solutions to problems of design not generally included in American texts. An interesting contrast is shown in the English, Swiss, French and American methods of determining the maximum bending moment in a slab supported on four sides. The American rule, unfortunately, is not the rule adopted by the "Joint Committee" which is so widely used.

The book is well illustrated with both line cuts and halftone views. Brief descriptions and principal dimensions of some of the more important bridges illustrated add interest to the book, as it is difficult to scale and visualize pictures without dimensions. The appendix includes a set of specifications for a reinforced-concrete bridge and a brief discussion of concrete materials. The specifications are of interest as indicating the practice in England, but they are not comprehensive enough to be of use as model specifications. British discrimination against limestone for concrete aggregate in bridge work is notable, as this material has been widely used in America with satisfactory results.

The book will be of value to most American engineers interested in concrete highway bridge work. It presents a somewhat different point of view and method of approach to the design problem from that usually given in American texts.

Sewage Sludge Digestion

REVIEWED BY DR. A. M. BUSWELL
Chief, State Water Survey, Urbana, Ill.

FORTSCHRITTE IN DER AUSFAULUNG VON ABWASSERSCHLAMM—By Dr. Max Prüss. Munich, Germany: R. Oldenbourg. Paper; 9x12 in.; pp. 35; 15 tables and 18 figures. 6 marks.

The author first reviews the general topic of sludge digestion, discussing the object of digestion and the results obtained. He then describes in some detail methods for calculating the size of digestion chambers. He points out the relation between the following factors: gas production, time, temperature, amount of sludge (expressed as dry weight of organic matter), water content and digestion chamber volume. The rather complicated interrelation of these various factors is clearly set forth by a series of curves. There is apparently some difference of opinion as to the exact constants to be employed in calculating one factor from another. The constants used are naturally those which have been determined by the author and his co-workers from a long series of records on the progress of digestion in the tanks operated by the Emschergenossenschaft. Even though these constants are not necessarily applicable to conditions in other places, the author has pointed out the method for solving the difficult problem of the construction of sludge-digestion tanks.

The economics of sludge digestion are next discussed. Comparison is made between gas yields at different temperatures and in tanks which are quiescent or subjected to the circulation of old sludge. A method is given for calculating the financial saving resulting from insulating tanks in which elevated temperatures are employed.

The monograph is summarized in 23 paragraphs of an approximate total of 2,500 words which will be helpful to those who read German with difficulty.

High Standard of First Edition Maintained

REVIEWED BY JOHN H. GREGORY

Consulting Engineer; Professor of Civil and Sanitary Engineering, Johns Hopkins University, Baltimore, Md.

AMERICAN SEWERAGE PRACTICE: Vol. I, Design of Sewers—By Leonard Metcalf and Harrison P. Eddy. New York and London: McGraw-Hill Book Co., Inc. Second Edition. Cloth, 6x9 in.; pp. 759; 305 line cuts and halftones; 167 tables. $7.

Fourteen years have elapsed since the first edition of this well-known book appeared. One of the authors, Mr. Metcalf, died in January, 1926, thus leaving the responsibility for the second edition on the surviving author, Mr. Eddy. In the Preface to the new edition Mr. Eddy makes fitting acknowledgment of the energy and enthusiasm devoted by Mr. Metcalf to the original preparation of the book. As the work of revision extended over several years, a material portion of the revision had been accomplished before the death of Mr. Metcalf and had the benefit of his criticism. Acknowledgment is also made of the important help of some of Mr. Eddy's partners and staff, as well as of others. The first edition was reviewed by the writer in 1915, and it is a pleasure to now have the second edition submitted to him for review.

Since the publication of the first edition American practice in sewer design has attained a greater degree of uniformity, considerable advance has been made in the methods of application of principles and there has been a material increase in the amount of pertinent information available. In the new edition there has been a considerable rearrangement of material, some chapters have been divided and others consolidated, many sections have largely been rewritten and as a whole the book has been made more nearly complete as a work of reference. The writer has, therefore, thought it better, in this brief review, to consider the book as a new one rather than to attempt to compare the two editions and point out the changes and additions.

In the Introduction (33 pp.) the authors set forth the lessons taught by early sewage-works, not only in this country but abroad, and give a valuable historical background with which every sewerage engineer should be familiar.

Chapter I (31 pp.) treats of the general arrangement of sewerage systems and the conditions governing a sewer plan. Sewers are classified, the general details of sewerage systems are discussed and brief mention is made of the depreciation of sewers. Forty-nine pages are devoted to hydraulics and 32 pp. to velocities and grades. Taking these two chapters together, the engineer will find the data necessary for solving most of the problems having to do with the flow of sewage. Many diagrams are included, a feature which should appeal to all as a means of greatly facilitating the solution of hydraulic problems. The fourth chapter discusses the measurement of flowing water and describes the methods commonly used for measuring the flow of sewage.

One of the most important subjects that the sewerage engineer has to consider is the quantity of sewage for which provision is to be made. This subject is well covered in 64 pp., and many excellent data bearing on the subject, and from numerous cities, are presented. Separate sewers and their design are briefly discussed in the sixth chapter.

The very important subjects of precipitation and stormwater runoff are given 71 pp. The intensity, duration and frequency of rainfall are discussed, and a few well-selected diagrams, illustrative of the subject, are included. Stormwater runoff is gone into in great detail and the "rational method" of estimating stormwater flow is well presented. Next the design of storm drains and combined sewers is taken up. An example is given to illustrate the method of designing a storm drain. Gaging of stormwater flow in sewers is given a separate chapter.

The various kinds of pipe used in the construction of sewers are given 26 pp. The chapter ends with a brief statement of practical deductions as the result of tests and experience. The chapter on masonry sewers (71 pp.) is an especially valuable one for the designing engineer, as the cross-sections of a large number of masonry sewers actually built are given. Data are also given on the wear on sewer inverts. In Chapters XIII and XIV (75 pp.) there is a full discussion of loads on sewers and of methods used to determine stresses in sewer sections, as well as of the amount of steel reinforcement needed, when steel is used. To inlets, catch-basins and manholes 46 pp. are given, including illustrations of actual practice in numerous cities.

In many ways Chapters XVI and XVII, totaling 93 pp., are among the most valuable. They deal with junctions, siphons, bridges, flushing devices, regulators, overflows, outlets, etc. Ordinary sewer design is pretty well standardized, but one meets with an almost infinite variety of special structures, not of name but of construction—some good, some bad. It is when the engineer or draftsman has a special structure to design and knows what he wants to accomplish, but has difficulty in visualizing the structure to be designed, that these two chapters are of help. Numerous special structures are illustrated, and in sufficient detail, to give the designer at least a good start on the solution of the problem confronting him.

The book concludes with 46 pp. on pumps and pumping stations. Various types of pumps are discussed and their advantages and disadvantages pointed out. Details are also given of a number of installations. What the authors have to say has of necessity been condensed, and, in so far as considered, has been well treated. From the writer's standpoint, however, a whole book could be well devoted to this very important subject.

The first edition of this book was well received by engineers and has been and still is a standard book of reference on the design of sewers. The high standard set by the first edition has been maintained in the second edition, and this new edition will stand in the first rank of books dealing with the subject treated. A 39-p. index helps make its contents readily available.

Engineering English

ENGINEERING ENGLISH—By John Hubert Scott, Associate Professor of English in the State University of Iowa. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5½x8¼; pp. 321. $2.75.

Professor Scott's book is designed to aid the student of engineering in his efforts to develop a mode of expression that shall combine accuracy, logicalness, orderliness and succinctness—in other words, to show

him how to make the English language one of his most useful tools. He points out that the phase "engineering English" is justified because the language of the engineer is different in vocabulary, distinct in its use of figures and abbreviations and of marked diversions in its criteria of excellence from that of the story writer, the dramatist and the essayist.

A course is outlined for the student that includes instructions on arrangement of manuscript, punctuation, use of capitals and italics, abbreviations, spelling, proper use of numerals and hyphenation. The various types of articles that an engineer is called upon to write are taken up, and rules are laid down as to the proper manner of treating each type. Of special value are the chapters on report writing and specification writing, for upon his ability to express himself accurately and concisely depends much of the engineer's success.

There are copious illustrative examples and numerous references to collateral books which elucidate in greater detail the points made by the author. It is a volume that might well be studied, not merely read, by every engineer.

The Principle of Similitude

REVIEWED BY I. GUTMANN
Associate Editor, Engineering Index, New York City

WASSERAFLUSS DURCH STOLLEN—Untersuchungen aus dem Flussbaulaboratorium der technischen Hochschule zu Karlsruhe—Von Dr.-Ing. Ernst Schleiermacher. Munich and Berlin: R. Oldenbourg. Paper; 8x11 in.; pp. vi + 55, illustrated. 5.5 marks.

UNTERSUCHUNG DER UEBERFALLKOEFFIZIENTEN und der Kolkbildungen am Absturtzbauwerk I im Semptflutkanal der "Mittleren Isar"—Von Dr.-Ing. Otto Kirschmer; Forschungsinstitut für Wasserbau und Wasserkraft e.v. Muenchen, Mitteilungen—Heft 1. Munich and Berlin: R. Oldenbourg. Paper; 7x11 in.; pp. vi + 39; illustrated. 4.5 marks.

DIE WASSERBEWEGUNG IM DAMMKOERPER—Von Ing. Ignaz Schmied. Vienna: Julius Springer. Paper; 6x9 in.; pp. viii + 200; 150 line cuts in text. 22 marks.

The three monographs before us bear witness to the successful practical development of a purely theoretical principle—the principle of similitude. This principle is of decidedly English origin. It was announced by Isaac Newton, in the form of a theorem, about two and a half centuries ago, then it lay dormant for about 200 years until Froude revived its possibilities as a powerful method for practical hydraulic research—specifically, for the study of problems involved in ship design. Later the principle was adopted with particular enthusiasm by the German school of hydraulicians, who endowed it with a refined technique and elaborate methods of analysis. Nowadays, it may be justly considered as *the* method of hydraulic research—in fact, all the great hydraulic laboratories of Europe and America are institutions for the study of the principle of similitude.

Dr. Schleiermacher's monograph is a sample of the similitude studies of the famous hydraulic laboratory of the Karlsruhe Institute of Technology. It presents the results of a model study of the flow of water through closed conduits, such as tunnels, aqueducts and culverts. Special attention is given to the case of submerged inlet with ample supply of air through a vent at the entrance of the conduit. The stream, in this case, performs what might be called a negative hydraulic jump: it contracts, its velocity correspondingly increases, and the conduit is not filled to its entire depth but acts as a flow-line aqueduct, waiving the opportunity for pressure flow.

The monograph by Dr. Kirschmer describes model experiments on the rounded crest weirs with the added complication of erosion downstream of the toe. It contains a thorough analysis of the causes of discrepancies and variations in the coefficient of discharge at low heads. The results of this investigation, made at the Munich hydraulic laboratory, were used in the construction of the waste weir of the Sempt canal of the Middle Isar project. Later the full-scale structure was calibrated by means of current meter measurements and the results showed a very satisfactory agreement with the laboratory model determinations. The predictions as to downstream erosion were not so satisfactory—the laboratory model was probably not large enough.

The monograph by Schmied is a similitude study of percolation of water through levee embankments. It presents the results of 100 experiments, made in 1909 and 1910 on models of levees of various materials and cross-sections of the order of magnitude of 40 cm. bottom width, 16 cm. in height. The results as to percolation curve, seepage discharge, effect of berms, deformation and failure of embankment, etc., generally agree to within 20 or 50 per cent with theoretical formulas developed in the book. The author, who was connected for 27 years with the Lower Austria Commission for the Regulation of the Danube, concludes that model experiments of the kind are of great practical value for the determination of the cross-section of levees required to withstand floods of given height and duration, and *vice versa*, for computing the potential resistance of embankments of given dimensions. A full translation, or at least a digest of this work, might be of great interest to them who may be charged with the design of the Mississippi levees.

Two Books for Students

REVIEWED BY LEWIS E. MOORE
Consulting Engineer, Boston, Mass.

STRENGTH OF MATERIALS—By Jasper Owen Draffin, M.S., Assistant Professor of Theoretical and Applied Mechanics, University of Illinois. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6x9 in.; pp. 275; frontispiece portrait of Thomas Tredgold and 187 line cuts. $3.

MECHANICS FOR ENGINEERS: Statics and Kinetics—By Julian C. Smallwood, M.Am.Soc.M.E., Associate Professor of Mechanical Engineering, Johns Hopkins University, and Frank W. Kovenhoven, Assoc.M.Am.Soc.M.E., Instructor in Mechanical Engineering, Johns Hopkins University. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. 185; line cuts. $2.50.

The author of Strength of Materials states in his Preface that his book was written for engineering students who had not studied the calculus. The reviewer is very favorably impressed by this book and sees no reason to restrict its use to students who have not had the calculus.

The subjects covered are: Direct stresses, materials and their properties, riveted joints, torsion, beams, bending and direct stress, deflection, statically indeterminate beams, combined stresses, columns, special loadings and reinforced concrete. There are also three appendices which present briefly certain portions of calculus, centroids of areas, and moment of inertia of areas. The parts which different men have taken in the development of the various theories and facts are covered historically by references which admirably emphasize the background for and the fundamental discoveries upon which the whole science of strength of materials rests.

In these days, when the tendency is to test everything rather than to bother to think about it, it is refreshing to find an author who draws the line between philosophical thought and laboratory testing so clearly and

with such sane balance as does Professor Draffin. Formulas are derived, but mere substitution of quantities in them is subordinated to the direct application of principles in the solution of problems. The three-moment equation and Euler's column formula are stated without derivation, although their use and limitations are carefully set forth. The subject of deflections is handled by the slope-area method. To complete the work the author should add somewhere the treatment of this subject by the elastic curve method, using the calculus.

The chapter on reinforced-concrete beams in refreshing in its presentation of the fundamentals with clearness, simplicity and avoidance of the alphabetical jungle with which most writers surround this subject. The author has done so well with the rest that it is too bad that he sidestepped the stirrup theory, although the reviewer must admit that he cannot blame him very severely for avoiding the presentation of a theory that does violence to so many of the established principles of strength of materials.

The treatment of the subjects throughout is clear and simple. In illustrating the applications of the various standard formulas, the author has carefully pointed out where the judgment which can only be obtained by actual experience in evaluating the effect of conditions must guide in the selection of the data to be used.

The reviewer feels constrained to quote the first paragraph of the Preface to Mechanics for Engineers:

In contributing this book to the flood of available literature on the subject, the authors claim nothing new except an arrangement and selection of material, a combination of problems with text for the exercise of the best pedagogy and an emphasis upon subjects important to engineering students, with corresponding omission or reduction of the less important ones. All of this is in conformity with modern methods of teaching, and is intended to meet the progress made by universities in the development of their engineering curricula *according to the demands of industrial requirements* (the italics are the reviewer's).

The whole trouble with the book is accurately stated in the last sentence of the preceding quotation. The author's interpretation of industrial requirements has resulted in a book which teaches how to solve certain problems but which otherwise lacks breadth of view. As might reasonably be inferred, the treatment of this most important branch of physics is not such as to develop a thorough understanding of its fundamental principles and laws on the part of the student.

A number of minor faults might be pointed out—for instance, the reversal, for no stated reason, of the usual convention that clockwise rotation has the negative sign; and the mention of friction, with its introduction as a fundamental condition, in a problem some 49 pp. before the subject is treated.

The student who completed this book would be apt to find himself reasonably well prepared to take a particular course in machine design and construction but lacking in the broad grounding in fundamentals which is nowadays more necessary than it has ever been heretofore.

Publications Received

BEHAVIOR OF PRICES, reviewed in these columns on Dec. 20, sells for $7, instead of $3.

DIGHE, the Italian book on dams reviewed on p. 929 of this section on Dec. 20, was written by Ing. Ittore Scimeni, whose name was unfortunately omitted in the heading to the review of the book by A. C. Janni.

A VARIETY OF INFORMATION on motor vehicle regulation, taxation and related matters is given in printed matter which may be had from the Motor Vehicle Conference Committee, Madison Ave. at 46th St., New York City.

THE HUME RESERVOIR, now under construction by the River Murray Commission, is the subject of a recent illustrated pamphlet. H. H. Dare, M.Inst.C.E., is Commissioner of Water Conservation and Irrigation, East Melbourne, N.S.W.

CORROSIVE EFFECT OF SLAG ON STEEL is the subject of Symposium No. 10 of the National Slag Association (Cleveland, Ohio). The pamphlet brings together an extensive digest of literature and correspondence relating to the alleged corrosive effect of slag both in fill and in concrete. It represents the most complete collection of information on this important subject yet published, and includes reports of observations on a number of buildings and other structures built of slag and concrete in which the character of embedded steel was subsequently observed. The evidence presented goes to show quite consistently that slag is devoid of corrosive effect on steel.

THE DETROIT WATER-WORKS and its various operations, as of Oct. 1, 1928, is described in a closely printed 59-p. pamphlet issued by the local water board. George H. Fenkell is superintendent and general manager and Daniel C. Grobbel is acting secretary.

AMONG PAMPHLETS being distributed by the American Management Association, 20 Vesey St., New York City, are: Should the Office and Factory Be Separated, by R. S. Mason, Office Supervisor, Fuller Brush Co.; Market and Statistical Research as an Aid to Budgeting, by C. F. Hansen, Director of Research, W. T. Grant Company; Financial Aspects of Industrial Pensions, Bryce M. Stewart, Industrial Relations Counselors.

CHICAGO'S FREIGHT TUNNEL SYSTEM, with 62 miles of narrow-gage electric lines forming a gridiron in the business district and extending to outlying sections, is described and illustrated in a 32-p. pamphlet by the Chicago Tunnel Terminal Corporation. This system serves warehouses, railway freight and passenger stations, post offices, newspaper offices, wholesale establishments, office buildings and building sites for the handling of freight, delivery of coal, removal of refuse and ashes and similar purposes.

A DIGEST OF SAND AND GRAVEL specifications has been published by the National Sand and Gravel Association, Washington, D. C. Prepared with evident care, it brings together from widely scattered sources a mass of valuable information as to size grading, composition and tests. Sand and gravel for concrete, bituminous road sand and building and plastering sands are the most important items for the civil engineer. A full analysis of state road specifications is given.

THE EARNING POWER OF RAILROADS is the title of a 568-p. book issued by James H. Oliphant & Company, New York and Chicago, giving summaries and statistics of mileage, earnings, expenses and financial details of individual railroads and the railroad system in general. Introductory chapters deal with accounting methods for the various classifications, such as income, operating expenses, maintenance-of-way and equipment, fixed charges; also the government valuation and the 1920 transportation act.

UNDER THE TITLE L'Etude de L'Aménagement et de L'Utilization des Sources D'Energie the Institut National Roumain (Bucharest, Roumania) is publishing a series of monographs (in French) covering a wide range of topics. Of these, No. 13 (53 pp.) presents a graphical method of determining the conditions of functioning of electric transmission lines, by T. Tanasesco, while No. 14 (142 pp.) deals with the canalization of the falls of the Bas-Danube in relation to transportation and traffic capacity. The author of No. 14 is Gregoire C. Vasilesco. Both of the pamphlets are illustrated.

"CONOWINGO" is the title of a handsome 32-p. booklet issued by Stone & Webster, Inc., Boston, to commemorate the completion of the largest development, steam or hydro-electric, constructed in one step in the history of the power industry. Details of the construction work are shown by many illustrations, a number of which are in colors. An unusual feature of historic interest is the reproduction on the inside front cover of the plans and charter of the proprietors of the Susquehanna Canal, organized in 1783 to construct a canal around the rapids of the Susquehanna near Conowingo. This canal was built, used and abandoned more than 50 years ago.

SEWAGE-WORKS of a number of American cities, most of the plants being of the activated-sludge type, are described by Kenneth

Allen, sanitary engineer of the Board of Estimate and Apportionment, New York City, following a brief summary report by Charles W. Berry, comptroller, and Arthur S. Tuttle, chief engineer of the board, of an inspection trip to the works described made early in 1928. Included in the same volume (96 pp.) is a preliminary report by George W. Fuller, consulting engineer, New York City, recommending the installation on Wards Island of an activated-sludge plant to treat a part of the sewage of New York City (see *Engineering News-Record*, May 17, 1928, p. 793, for abstract of Mr. Fuller's report.)

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

ACCELERATION STRESSES IN HOISTING ROPE—By G. P. Boomsliter. Research Bulletin No. 2, Engineering Experiment Station. Morgantown, W. Va.: West Virginia University. Paper; 6x9 in.; pp. 79; line cuts and halftones.

APPRAISAL OF URBAN LAND AND BUILDINGS: A Working Manual for City Assessors—By Cuthbert E. Reeves, Consulting Engineer, Buffalo, N. Y. New York: Municipal Administration Service. Paper; 6x9 in.; pp. 180; diagrams and and many tables in text, and five folding plates of curves. 50c.

Based on years of practical experience, the author has presented a few pages of explanatory text and many tables, diagrams and curves designed to show how to avoid guesswork, favoritism and worse in appraisal work. Broadly, he correlates land values with utility, location and topography, while for buildings he uses reproduction cost less depreciation. The monograph might well be in the hands of every tax assessor and other person engaged in the valuation of lands and buildings. The fact that it is written by an engineer should appeal to the readers of these columns.

ATLAS OF THE COMMERCIAL WOODS OF THE UNITED STATES—By H. P. Brown, Professor of Wood Technology, Syracuse, N. Y.: Extension Department, New York State College of Forestry, Syracuse University. Paper; 6x9 in.; pp. 6 + 60 plates. $2, bound or in loose-leaf form optional.

Designed for the identification of 57 commercial timbers. Fine halftones of magnified photographs of transverse sections of the 57 varieties of wood, with three other plates illustrating special points.

BETON ARME—Par Victor Forestier, Ingenieur Constructeur (A. & M.) M. Soc. Ing. Civils de France. Second edition, 1929. Paris: Dunod, 92 Rue Bonaparte (VI). Flexible; 4x6 in.; pp. 360 + XLII pp. of tables, bibliography, etc.; line cuts. 17 francs.

In the re-edition of this handbook on reinforced concrete material has been added on calculations for bridges and the resistance of mortars made of supercement and alumina cement, increasing the main text by 4 pp. and the appended tables, etc., by 10 pp. The first edition was noted briefly in these columns on Feb. 16, 1928, p. 289.

CATSKILL WATER SUPPLY: A General Description (Revised to December, 1928). Paper; 6x9 in.; pp. 50; illustrated. Apply to Board of Water Supply, Municipal Building, New York City.

COMPARATIVE TAX RULES of 237 Cities, 1928—By C. E. Rightor, Chief Accountant, Detroit Bureau of Governmental Research. Reprinted from National Municipal Review, December, 1928. Paper; 6x9 in.; pp. 12; mostly tables.

CONCRETE, A Study of the Failure of Under Combined Compressive Stresses—By Frank E. Richart, Research Associate; Prof. Anton Brantzaeg, Graduate Student, and Rex L. Brown, Research Associate, in Theoretical and Applied Mechanic, University of Illinois. Urbana: Engineering Experiment Station. Paper; 6x9 in.; pp. 104; diagrams and halftones. Limited number of copies free; additional copies, 55c.

CONCRETE, Effect of Physical Properties of Stone Used as Coarse Aggregate on Wear and Compressive Strength—By H. R. Thomas and G. A. Parkinson. Austin, Tex.: University of Texas. Paper; 6x9 in.; pp. 32. Line cuts.

CONCRETE DRAIN TILE, Action of Alkali Salts on—By W. J. Schlick, Drainage Engineer, Iowa Engineering Experiment Station. Paper; 6x9 in.; pp. 48; diagrams and many tables. Free.

CONCRETE IN TENSION AND COMPRESSION, Relationship Between Strength and Elasticity—By James W. Johnson, Assistant Laboratory Chief, Iowa Highway Commission. Paper; 6x9 in.; pp. 43; diagrams and halftones. Free on application to Director, Engineering Experiment Station, Ames, Iowa.

DIATOMITE: Its Occurrence, Preparation and Uses—By V. L. Eardley-Wilmot. Ottawa, Ont.: Department of Mines. Paper; 7x10 in.; pp. 182; illustrated; folding map in pocket.

Covers other countries as well as Canada. Contains bibliography.

DIGEST OF THE LITERATURE on the Nature of the Setting and Hardening Processes in Portland Cement—By R. H. Bogue, Research Director, Portland Cement Association Fellowship, Bureau of Standards, Washington, D. C. Paper; 6x9 in.; pp. 48. Free on application.

Topical digest, followed by bibliography.

DISCHARGE CHARACTERISTICS OF SUBMERGED JETS—By M. J. Zucrow, Research Associate, Engineering Experiment Station. Lafayette, Ind.: Purdue University. Paper; 6x9 in.; pp. 67; 21 diagrams.

ENGINEERING DRAWING THEORY WITH APPLICATIONS—By Frank Kerekes, Assoc.M.Am.Soc. C.E.; Structural Engineer; Associate Professor of Civil Engineering, Iowa State College, Ames, Iowa. With Appendix: Engineering Lettering and Drafting. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6x9 in.; pp. 293; illustrated. $2.50.

Designed as a "comprehensive text for teaching first-year college drawing courses," with "primary emphasis" placed on "the thought processes by means of which the student derives the basic principles and applications of drawing through his own initiative and effort." Contains many exercises "to develop the underlying theory of the subject" and also drill problems for "rapidly testing the student's understanding of the theory developed by the exercises." The many sketches are well drawn, lettered and reproduced but the few plates showing general drawings of the whole or parts of industrial plants are poor because of failure to redraw and reletter them for reproduction on the small scale used. Moreover, the book does not seem to contain even a paragraph on drawing and lettering for reproduction, a topic which might well be taken up, if very briefly, in books even more elementary than this one.

HANDBUCH FÜR EISENBETON BAU—Dritte Neubearbeitte Auflage. Herausgegeben von Dr. Techn. H. C. F. Emperger. Neunter Band: Die in- und Ausländischen Eisenbetonbestimmungen. Bearbeitet von J. Lorenz-Meyer. Berlin: William Ernst & Sohn. Paper; 7x10 in.; pp. 290; line cuts. Paper, 17 marks; bound, 19.5 marks.

(To be continued)

Letters to the Editor

Fireproofed Lumber For Scaffolding

Sir—In an editorial in the Jan. 3 issue you commented on the subject of "Burning Scaffolding," the latest occasion being the fire in the Riverside Church in New York City with a reported fire loss of several hundred thousand dollars. In the May 21, 1927, issue of *Engineering News-Record* the reported loss of the Sherry-Netherland Hotel fire was $516,000, and in the Sept. 1 issue of the same year fire in the falsework of the Washington Boulevard bridge in Pittsburgh caused a reported loss of $81,000.

In none of these cases, and they are only a few of the many which occur every year, are any figures given which show the amount or value of the temporary construction timber involved. Undoubtedly its value was relatively insignificant as compared with the total damage done to the structure in question, and nothing is said about the loss to the owner due to delay in completion of the structure.

In this most recent instance the indications are that the contractor had taken every reasonable precaution, and still the fire occurred. Is it not time that serious consideration be given to the need for fireproofing treatment of construction timber used in building construction? Fireproofing of wood is not unknown and may be said to have passed the experimental stage, since there are commercial plants in operation for such treatments. Certainly the cost of such treatment is a mere trifle compared with the money loss from fires of such proportion as those referred to; and since a considerable part of such timber is used several times on the same job and frequently on more than one job, its cost could be distributed over more than one operation.

The writer speaks from several years' experience, part of it on large building construction, when he makes the statement that, in spite of the utmost care that a building superintendent can exercise and despite rigid enforcement of rules regarding various items which are considered fire hazards, it is next to impossible to control the situation completely. The character of temporary wiring, the extent to which certain building materials such as architectural tile, enameled brick, porcelain ware and many other materials are received and stored in very inflammable packing and crates, and the fact that many workmen smoke, make the danger from a fire doubly great; and once such a fire has gained much headway, it is often quite difficult to control.

The fireproofing treatment of temporary construction timber would do much toward the elimination of this kind of loss and is one for which the owner should be willing to bear the cost. Undoubtedly better insurance rates during construction would be allowed where all such temporary timbers were so treated.

HOWARD H. GEORGE,
Superintendent of Research,
Cleveland Railway Company.

Cleveland, Ohio
Jan. 7, 1929.

News of the Week

Supreme Court Rules Chicago Diversion of Lake Michigan Illegal

Decision States Water Cannot Be Turned to Another Basin Except for Navigation

IN A SWEEPING decision of the U. S. Supreme Court, rendered Jan. 14, diversion of water from Lake Michigan for the dilution and disposal of the sewage of the Chicago Sanitary District is held to be illegal. The highest court of the land, without dissenting vote, declares that the only legal ground for diversion is for the purposes of navigation in the Port of Chicago, including the Chicago River, and that the warrantable quantity for that purpose is but a small part of the 8,500 sec.-ft. authorized by the Secretary of War under the permit of 1925, that amount being justifiable only as a temporary measure. The exact amount which may be legally diverted is left to expert determinations before the formal decree is issued by the court. Meanwhile, the technical questions have been referred to Charles Evans Hughes, in continuation of his previous services as Master in behalf of the Supreme Court.

Many States Complained

The decision results from complaints brought by all the states bordering on the Great Lakes, except Illinois and Indiana, against the State of Illinois and the Chicago Sanitary District for an injunction against the lowering of the levels of the Great Lakes to the injury of navigation.

An extended abstract of the decision will be given in a later issue. The concluding part of the decision follows:

In increasing the diversion from 4,167 sec.-ft. to 8,500 the Drainage District defied the authority of the National Government resting in the Secretary of War. And in so far as the prior diversion was not for the purpose of maintaining navigation in the Chicago River it was without any legal basis, because made for an inadmissible purpose. It therefore is the duty of this Court by an appropriate decree to compel the reduction of the diversion to a point where it rests on a legal basis and thus to restore the navigable capacity of Lake Michigan to its proper level. The Sanitary District authorities, relying on the argument with reference to the health of its people, have much too long delayed the needed substitution of suitable sewage plants as a means of avoiding the diversion in the future. Therefore they cannot now complain if an immediately heavy burden is placed upon the District because of their attitude and course. The situation requires the District to devise proper methods for providing sufficient money and to construct and put in operation with all reasonable expedition adequate plants for the disposition of the sewage through other means than the Lake diversion.

Though the restoration of just rights to the complainants will be gradual instead of immediate it must be continuous and as speedy as practicable, and must include everything that is essential to an effective project.

To determine the practical measures needed to effect the object just stated and the period required for their completion there will be need for the examination of experts, and the appropriate provisions of the necessary decree will require careful consideration. For this reason, the case will be again referred to the Master for a further examination into the questions indicated. He will be authorized and directed to hear witnesses presented by each of the parties, and to call witnesses of his own selection, should he deem it necessary to do so, and then with all convenient speed to make report of his conclusions and of a form of decree.

Modified Completion Lafayette Dam Recommended

Recommending completion of the Lafayette Dam in California on an extremely conservative design with a decrease of 40 ft. in height and 65 per cent less storage, the consulting board composed of C. D. Marx, C. H. Paul, A. J. Wiley and F. L. Ransome, appointed to examine this structure after the recent subsidence, rendered its report to the East Bay Municipal Utility District on Jan. 14.

In substance the report finds: The foundation subsidence of this 140-ft. rolled-fill earth dam was caused by too great a concentration of load on an unusually thick and plastic deposit of alluvium not disclosed by the original borings. The dam was well designed and constructed for ordinary foundation conditions, but the partial failure demonstrates the need of exhaustive study for earth dams on thick alluvial deposits. Some storage is necessary at this point for aqueduct operation. Completion of the dam to within 40 ft. of the original height on a base twice the original width is safe and is recommended. This would afford 3,700 acre-ft. storage. Restoration and completion along these lines would cost about $300,000.

The subsidence of this dam was reported in *Engineering News-Record* Sept. 27, 1928, p. 483 and announcement of the consulting board's appointment appeared Oct. 25, p. 635.

Next Safety Congress in Chicago

The Eighteenth Annual Safety Congress will be held in Chicago from Sept. 30 to Oct. 5, 1929, according to W. H. Cameron, managing director. Preparations are being made to accommodate 7,000 delegates.

Condition of Arizona High Multiple Arch Dam Cause of Grave Concern

Investigation of Lake Pleasant Dam Reveals Cracked Buttresses—Water to Be Kept Low

VERTICAL cracks in the buttresses and question about the foundations of the 170-ft. Lake Pleasant multiple arch dam in Arizona have caused apprehension as to the safety of the structure if the reservoir were to fill. A report dated Dec. 15, of a committee of three consisting of F. L. Ransome, J. B. Lippincott and D. C. Henny, recently made public by the Arizona State Water Commissioner, recommended caution in operation of the storage reservoir. As a result of this report, the Water Commissioner ordered that the stored water should not be allowed to rise above a level 41 ft. below the top of the dam and, on Jan. 8, the Commissioner appointed a general engineering board of fourteen members, including Messrs. Lippincott and Henny and representatives of various state departments utilities, and organizations directly interested, this board being instructed to determine whether immediate action is necessary and if so what emergency measures should be taken.

Heavy Floods Possible

The situation is complicated on the one hand by the fact that the area whose irrigation depends on the stored water would be seriously injured by wastage and, on the other hand, by the small capacity of the outlet through the dam when considered in relation to the streamflow. Streamflows as high as 100,000 sec.-ft. are believed to be not improbable. The 1927 runoff through the reservoir was 190,000 acre-ft. in two days, the peak of this flood being 65,000 sec.-ft. In the event of a maximum flood, therefore, which might occur at this time of the year, the reservoir would fill very quickly. The present depth of water in the reservoir is 49 ft.

This dam, completed in Sept., 1927, and described in *Engineering News-Record*, Feb. 2, 1928, p. 180, is on the Agua Fria River, about 35 miles northwest of Phoenix and creates a storage reservoir for the Maricopa County Municipal Water Conservation District No. 1. The buttresses of the multiple arches are 60 ft. from center to center and the dam is 2,146 ft. long. The reservoir capacity is 170,000 acre-ft. below the level of the spillway lip which is 154 ft. above stream bed. The dam as a whole was designed by the monolith theory and the arches by the elastic theory.

Dean Anson Marston Elected President of Civil Engineers

New Head of Am.Soc.C.E. Long Active in Engineering Practice and Education

ANSON MARSTON, who was elected president of the American Society of Civil Engineers at the opening of its 76th annual meeting yesterday, was born in Seward Township, Ill., May 31, 1864. He was educated in local schools and then taught school for two years before entering Berea College, Berea, Ky., in 1884. The following year he went to Cornell University, where he was graduated in civil engineering in 1889. While in college he spent his summer vacations as a rodman on the Illinois Central Railway and upon graduation became first an instrumentman and subsequently resident engineer and chief of party on railroad and bridge locations and construction, mostly on the Missouri Pacific Railway in Arkansas, La.

At Iowa State Since 1892

In 1892 Mr. Marston went to Iowa State College, Ames, Iowa, as professor of civil engineering, which position he held until in 1904 he was made engineering dean and director. He has continued as dean since that date.

Along with his college work Dean Marston has found time to devote to the practice of civil engineering, specializing in bridges, sewage disposal, drainage, water supply and highways. During the World War he served from July, 1917, to December, 1918, as a major and then as a lieutenant colonel of Engineers in the army. In 1924 and 1925 he served as a member of the Engineering Board of Review of the Sanitary District of Chicago and in 1927 as a member of the Engineering Board of Review of the Board of the Florida Everglades.

Dean Marston has been active in engineering societies in many capacities. He was president of the Iowa Engineering Society in 1900, of the Land Grant College Engineering Association in 1914 and of the Society for the Promotion of Engineering Education in 1915. In 1924-25 he served as member of the executive committee of the American Society of Testing Materials; he also served two terms as a member of the National Research Council and is at present chairman of the Advisory Board on Highway Research. He has served the American Society of Civil Engineers as a director (1920-22) and as vice-president (1923-25).

The honorary degree of Doctor of Engineering was conferred upon Dean Marston by the University of Nebraska in 1925, and a similar degree was conferred upon him by the Michigan State College in 1927.

Other Officers Elected

Other officers elected were: Vice-president, Arthur James Dwyer, president and chief engineer of the Nashville Bridge Company, and A. J. Hammond, consulting engineer, Chicago; directors, George H. Norton, chief engineer of the Buffalo Grade Crossing and Terminal Station Commission; Frank Lee Nicholson, chief engineer of the Carolina Railroad; Ralph Budd, president of the Great Northern Railway; Albert F. Reichmann, division engineer of the American Bridge Company at Chicago; Clyde T. Morris, professor of structural engineering at Ohio State University, and Joseph Jacobs, consulting engineer, Seattle, Wash.

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DEAN ANSON MARSTON

Honorary Membership

Honorary membership in the society was conferred upon J. Waldo Smith, consulting engineer to the Board of Water Supply, New York City. Mr. Smith's election to honorary membership was announced following the fall meeting of the society at San Diego.

Action by the Board

The board of direction at its meeting on Jan. 15 and 16 took further action looking toward joining the Engineering Council. The president and secretary were authorized to initiate the necessary proceedings that the society may become a member and an item for dues was included in the budget. This action was taken in view of the action of Engineering Council as noted elsewhere on this page.

Efforts to bring more general uniformity into the registration laws in the several states having engineer license laws and in states where licensing is proposed are to be made by the board's committee on registration.

A report by Allen Hazen on the desirability of forming a special committee to study the design and construction of high dams was received and approved by the board and referred to one of its committees to draft details of procedure.

Formation of a new section in Florida, to include all of the state outside of the part now included in the Miami section, was authorized.

A resolution urging upon the President and upon Congress the need for a national hydraulic laboratory in the Bureau of Standards was adopted.

The report of the Technical expansion committee was received and discussed at length and action taken looking toward bringing certain phases of the report into effect.

A report dealing with engineering societies in foreign countries was received by the board. It was prepared with the idea of adopting a list of such societies, membership in which would be a pre-requisite to membership in the society for persons applying from other than the continental United States and Canada.

Engineering Council Adopts Modification Of Its Constitution

Changes Will Make It Possible for American Society of Civil Engineers to Join

A STUDY of the federal government's policy under which a large amount of public work is performed by the Corps of Engineers is to be undertaken by a committee of three members to be appointed by the president of American Engineering Council and confirmed by its board. Before taking this action at the annual meeting of the Council, there was general discussion of the work of the army engineers, in which they were severely criticized.

The Council also approved an amendment to its constitution under which each member organization will retain its autonomy in the expression of independent viewpoints and in taking action to support them another amendment adopted provides that no action may be taken if it is opposed by the vote of (a) one-half of the total number of the representatives of any of the national member organizations having six or more representatives on the Assembly; (b) one-half of the aggregate of the representatives of other national member associations; (c) one-half of the aggregate of the representatives of the local, state and regional member associations. This amendment does not apply to the election of officers, the eligibility of representatives, the admission of members, the amendment of the by-laws and standing rules and matters of a routine nature.

Steps were taken looking to the securing of action on the bill providing for a national hydraulic laboratory. The amendment to the federal constitution proposed by Arthur E. Morgan vesting broader authority in the federal government over interstate waters was endorsed. The report on traffic signs and signals was approved.

Two new vice-presidents were elected for two-year terms. They were P. Alford and O. H. Koch. H. E. Howe was re-elected treasurer for a term of one year. The term of the president, A. W. Beresford and of vice-presidents I. E. Moultrop and Gardner Williams, still have another year to run.

Annual Award of Medals and Prizes by the American Society of Civil Engineers

THE following men were recipients at the annual meeting in New York Jan. 16 of the various medals and prizes awarded by the American Society of Civil Engineers for meritorious papers presented during 1928.

Arthur M. Wellington Prize

ROY G. FINCH, whose paper on "New York State Barge Canal and Its Operation" won for him the Arthur M. Wellington prize, was born in Granville, N. Y., in 1884 and received his preliminary education in the public schools of that city. He graduated with the degree of civil engineer from Rensselaer Polytechnic Institute in 1906. During 1906 and 1907 he was engaged in railroad work and in 1908 entered the department of the State Engineer and Surveyor of New York as a levelman and remained in the department until the end of 1922. During this period he served as assistant engineer, supervising engineer, assistant division engineer, division engineer, assistant deputy state engineer and deputy state engineer, occupying the latter position for four years. During these fifteen years practically the entire work of constructing the New York State Barge Canal and its terminals was carried through to completion.

During 1923 and 1924 Mr. Finch was engaged in private practice as a consulting engineer. In 1924 he was elected State Engineer and Surveyor of New York and served in that position during 1925 and 1926, being the last elective State Engineer, as the office was made appointive beginning Jan. 1, 1927. Mr. Finch resumed private practice as consulting engineer in 1927 in Albany, N. Y. He has recently been appointed by the Board of Regents of the University of the State of New York as a member of the New York State Licensing Board for Engineers.

Thomas Fitch Rowland Prize

RODERICK B. YOUNG, recipient of the Thomas Fitch Rowland prize for his paper on "Producing Concrete of Uniform Quality," was born at Minneapolis, Minn. He graduated from the University of Toronto in 1913, and in 1919 was granted the degree of Civil Engineer for research in the design of concrete mixtures. His first engineering work was with the Canadian Pacific Railway on railroad construction in western Canada. Later he was employed in the shops and sales office of the Canadian Westinghouse Company. In 1913 Mr. Young joined the laboratory staff of the Hydro-Electric Power Commission of Ontario. In 1916 he organized and took charge of the engineering materials laboratories of the commission, to which in 1918 was added a chemical laboratory, and in 1920 the structural inspection department. At present he is testing engineer in charge of these three sections of the commission's testing and inspection department.

Mr. Young has devoted a great deal of study to concrete and concrete materials, and has acted as consultant to the commission on these matters in all its major projects since 1919, besides acting as consultant on many outside concrete structures. He is active in standardization and research, and is a member of many committees engaged in this work. He is a member of the Professional Engineers of Ontario, Canadian Engineering Standards Association, American Society for Testing Materials, American Concrete Institute and the Engineering Institute of Canada.

Mr. Young is the author of a number of papers and articles on concrete and concrete materials.

Norman Medal

CHARLES E. SUDLER, recipient of the Norman medal for his paper on "Storage Required for the Regulation of Stream Flow," was born in Baltimore, Md. Although he has been engaged principally in the civil engineering field, he has been largely interested in mechanical engineering and is responsible for considerable designing work in that line. He began his career as a mechanical draftsman for Murrill & Keizer, of Baltimore, in 1896. In 1898 he became a draftsman for the Baltimore & Ohio Railroad and was engaged in rebuilding the lines west of the Ohio River. In 1902 he became engineer and superintendent for Hoover & Kinnear, contractors, of Columbus, Ohio. In this capacity he was connected with bridge construction, track elevation work and heavy masonry, earthwork and tunnel construction for several railroad companies.

In 1907 and 1908 Mr. Sudler was engineer for the Hamilton Manufacturing Company, of Columbus, and designed and developed coal-storage and mine-loading machinery. In 1908 he returned to private practice in Baltimore and was then made principal assistant engineer of the Harbor Board of Baltimore. From 1911 to 1913 Mr. Sudler was engineer for the Furst Concrete Scow Construction Company, of Baltimore, and designed and built its plant and a 500-ton reinforced-concrete barge, the first to be launched in the East. In 1913 he was superintendent of construction on the million-dollar Perry Memorial on Lake Erie at Put-in-Bay. In 1918 Mr. Sudler came to New York City and was associated for five years with Parsons, Klapp, Brinckerhoff & Douglas. With this association he made a study of the hydrology of the streams of New York State.

Shortly after the organization of the Suburban Transit Division of the Port of New York Authority, Mr. Sudler joined that department and has remained there to date.

Collingwood Prize for Juniors

FRANKLIN HUDSON, JR., winner of the Collingwood prize for his paper on "The Design, Construction and Operation of a Small Sewage Disposal Plant," was born Feb. 2, 1901, at Kansas City, Mo., and received his education in the public schools of that city. He entered the employ of the Santa Fe Railway at Topeka, Kan., in 1918 as a chainman in the division engineer's office on general maintenance-of-way and concrete construction work. He became associated with the Benham Engineering Company, consulting engineers, Oklahoma City, Okla., in 1919 as assistant resident engineer on construction of a sewerage system and disposal plant at Globe, Ariz. He has been associated with the Benham Engineering Company continuously since that date except for a short time in 1920 as resident engineer on a hydro-electric project in Nebraska, two months in 1922 with the Santa Fe Railway on main line renewal in Illinois, and three months in 1923 as draftsman for the Kansas City Southern Railway.

Mr. Hudson served as resident engineer on construction work and assistant engineer on surveys and design for seven years and in January, 1927, became secretary-treasurer and associate engineer of the Benham Engineering Company. He is a registered civil engineer in the State of Colorado.

James Laurie Prize

JAMES F. CASE received the James Laurie prize for his paper on "The Ancient Roman Aqueduct at Athens." He was born in Columbus, Wis., in 1868, and in 1885 joined the C.B.&Q. Railroad as a rodman. From 1886 to 1888 he was a special student in civil engineering at the University of Wisconsin and during the latter part of 1888 and 1889 was assistant engineer at Portland, Ore., for the Northern Pacific Terminal Company in charge of construction of ter-

minals, grounds, buildings and a drawbridge across the Willamette River. Following this for a short time he was assistant division engineer of the Union Pacific system. From 1891 to 1893 he was chief engineer of the Metropolitan Street Railway of Portland and during the succeeding two years was assistant engineer of the Portland water-works in charge of construction of pipe lines and reservoirs.

Mr. Case was assistant engineer of the Astoria (Ore.) water-works in 1895 and 1896, in charge of pipe-line construction. He remodeled the water-supply system of Oregon City in 1896 and served as assistant engineer of the city of Portland during the following two years. From 1898 to 1901 Mr. Case served as captain and major in the U. S. Army as division engineer on the staff of Major General H. W. Lawton.

He was U. S. assistant engineer in charge of harbor improvements at Manila, P. I., from 1901 to 1903, and from that time until 1910 was engaged in a study of the water supply for Manila and in the water-power possibilities of the Philippine Islands.

Mr. Case made a study and reported on the hydro-electric possibilities of northern Italy during the period from 1918 to 1922. From 1923 to 1928 he was consulting engineer for Ulen & Company, of New York City. In March, 1928, he joined the firm of Stone & Webster and took charge of their office in Paris in the investigation of public utilities and valuation work in Europe.

Mr. Case served on the technical committee of the League of Nations, reporting on navigable waters of Poland and the drainage of the marshes of Polesia. He is an honorary member of the Civil Engineers of France and a member of the joint committee on co-operation between international technical bodies, appointed by the four founder societies of the United States together with the engineering societies of England and France.

Proposed Cumberland Falls Project Meets Opposition

A brief filed with the Federal Power Commission Dec. 31 by a number of nation-wide, state and municipal organizations voices opposition to the proposed power development of the Cumberland Falls in southeastern Kentucky. An application for a license to develop the project by the Cumberland Hydro-electric Company has been pending before the commission for about two years and was the subject of a recent hearing by that body at the Department of Interior in Washington. Opponents of the project declare that it would virtually destroy "the finest waterfall, except Niagara, east of the Rocky Mountains," and would impair the natural beauty of the surrounding region. Senator Coleman du Pont, of Delaware, a native of Kentucky, has offered to purchase the Cumberland Falls site and present it to the state as a public park.

E. C. Hutchinson to Leave Pacific Coast

Ely C. Hutchinson, president and general manager of the Pelton Water Wheel Company, of San Francisco, and well known throughout the West as a leading authority on hydraulic power development, has resigned and, beginning Feb. 1, will take charge of the engineering department of the M. W. Kellogg Company, of New York City, with headquarters at Jersey City, N. J. Mr. Hutchinson has served in various capacities with the Pelton organization since 1907, during which time he has been closely identified with progress in the waterpower field, particularly in pioneering work on high-head reaction turbines, developing units of record size for high-head turbines of both reaction and impulse type, and in the improvement of details in hydraulic prime movers and governors. He is a past-president of the San Francisco Engineers' Club, has taken a prominent part in engineering society activities all along the Pacific Coast and has devoted much time to committee work on hydraulic problems. In his new capacity with the Kellogg company he will have the title of director of engineering and will take complete executive responsibility for engineering in that organization.

Petition for Boston Back Bay Union Station Rejected

The Massachusetts State Department of Public Utilities has dismissed the petition of Mayor Nichols, of Boston, that the department order the New York, New Haven & Hartford Railroad, the New York Central Railroad and the Boston & Albany Railroad to provide a single union station in Dartmouth St. The department's decision reads in part as follows:

> The jurisdiction of this department to make the order requested is based upon Chapter 159, Section 16 of the General Laws. This jurisdiction can be exercised only when the regulations, practices equipment, appliances or service of the common carrier are "unjust, unreasonable, unsafe, improper or inadequate." It follows that the department, in determining the question before it, has no legal right to base its order solely upon the merits or desirability of a union station, or upon the development of the locality or the community, or upon the relief of street traffic congested, or upon any other similar factors, and can consider such factors only in so far as they play a part in determining whether the equipment, appliances, or service are unjust unreasonable, unsafe, improper or inadequate. The legislature may have the power to deal with the problem generally; we have not.

The department adds, however, that after the new Back Bay station of the New Haven, now under construction, is completed, if time and experience should demonstrate that the service is inadequate or improper, a petition for a union station may again be presented.

Maryland Highways Department to Be Reorganized

John N. Mackall, for nine years chief engineer of the Maryland State Roads Commission, will tender his resignation to a new commission that has been appointed by Gov. Albert C. Ritchie. Until about two months ago Mr. Mackall also served as chairman of the commission. When he resigned that position Oscar F. Lackey, another prominent engineer, was appointed chairman but died before taking office. The two remaining members of the commission, R. Bennett Darnall and W. W. Brown, resigned recently. Mr. Mackall's resignation enables the new commission to bring about a complete reorganization of the State Highway Department.

The new commission is composed of G. Clinton Uhl, chairman; Howard Bruce and John K. Shaw. Mr. Uhl served for many years as a member of the Board of Roads Directors of Allegany County, under whose direction many improved roads were constructed. He also served as a member of the State Roads Commission on a previous occasion. Mr. Bruce has had extensive experience as a gas engineer and manufacturer of ammunition and gas tanks. He is the chairman of the board of the Bartlett-Hayward Company, Baltimore. Mr. Shaw is at the head of a large coal company and is associated with numerous financial institutions.

German Professor to Lecture on Hydraulic Laboratory Research

Prof. Theodore Rehbock, of Karlsruhe, Germany, one of the most eminent of European professors and practitioners in river and harbor engineering, has accepted the invitation of President Stratton to come over to the Massachusetts Institute of Technology at Cambridge for a course of twelve lectures, beginning March 21. These lectures will be on the use of the hydraulic laboratory in research. Professor Rehbock will be accompanied by one of his sons as his secretary, and proposes to make a brief tour of American and Canadian water-power developments, after completing these lectures.

Columbia River Power Sites Under Consideration

The Washington Electric Company, of Seattle, a Stone & Webster concern, has applied to the Federal Power Commission for a preliminary permit covering a power site on the Columbia River 12 miles below Wenatchee, Wash., in the west channel of the river near the lower end of Rock Island. The ultimate installation will be 144,000 kw. Development of the Columbia River's power possibilities was suspended for some time pending a study of the proposed Columbia basin irrigation project. The Department of the Interior finally came to the conclusion that several decades must pass before the project likely would be undertaken.

New Orleans to Expand Sewerage System

Bids have been advertised for by the New Orleans sewerage and water board for extensions to the buildings and foundations at drainage pumping station No. 6, and for motors to operate four of the additional pumps now under construction, which will more than double the present capacity of 2,800 cu.ft. of water per second against a lift of 10 ft.

Bids have also been asked for an extension to the main drainage canal, to connect the Nashville Ave. canal to drainage pumping station No. 1.

These contracts form part of the $14,700,000 expansion program of the sewerage and water board for the next three years, authority for which was voted by the people of New Orleans several months ago.

Highway Conference at Univ. of Michigan

The Fifteenth Annual Conference on Highway Engineering will be held at the University of Michigan, Ann Arbor, Feb. 19-22. Speakers from outside the state will be R. M. Smith, Deputy Minister of Highways, Ontario, Canada; Robert Kingery, General Manager, Chicago Regional Planning Association; P. J. Freeman, Chief Engineer of Tests, Allegheny County, Pennsylvania; and Robert H. Ford, Assistant Chief Engineer, Chicago, Rock Island and Pacific Railway.

Three Power Projects Proposed in Eastern Tennessee

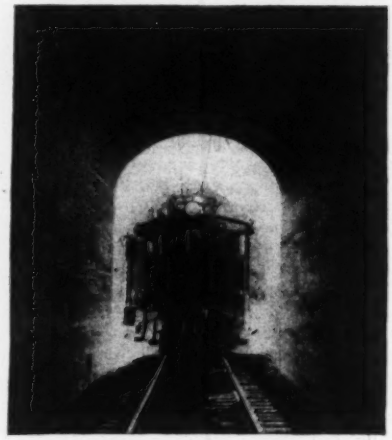
Three hydro-electric power projects involving an expenditure of $15,000,000 within the next three years is proposed by the Holston River Power Company for eastern Tennessee, according to an application filed with the State Railroad and Public Utilities Commission recently. The three projects contemplated are as follows: (1) Dam 79 ft. high with a generating plant capable of developing 24,000 hp., to be located 6 miles above Kingsport on the Holston River; (2) 30,000-hp. generating plant and dam, 135 ft. high, to be located just below the confluence of the South Fork and Holston rivers; (3) 130-ft. dam and plant with a capacity of 20,000 hp. to be built just above Bluff City on the South Fork River.

The application of the Holston company is the first since the recent opinion of the Supreme Court in which it was held that the railroad commission had a right to grant or withhold certificates after a hearing.

Great Northern Opens Cascade Tunnel With Wide Radio Broadcast

Hoover, Budd, Atterbury and Campbell Speak Over Air During Dedication Ceremonies

AS THE FIRST train of the Great Northern Railroad entered the new Cascade tunnel in Washington on Jan. 12, Ralph Budd, president of the road, dedicated the bore to James J. Hill in ceremonies that were broadcast through a nation-wide radio chain. Mr. Budd, talking from the east portal at Berne, Wash., paid tribute to his engineering associates and to A. Guthrie & Company, contractors on the project, for the remarkably fast construction schedule maintained, breaking the world's record in tunnel driving. The tunnel's length of 41,152 ft. was driven in just three years' time, lacking one week. The concrete lining was completed two weeks later.



NEW CASCADE TUNNEL, GREAT NORTHERN RY.

THOSE IN ACTIVE CHARGE OF BUILDING THE TUNNEL
Left, W. E. Conroy, superintendent, A. Guthrie & Company; center, Frederick Mears, asst. chief engineer, Great Northern Ry.; right, J. C. Baxter, vice-president, A. Guthrie & Company.

Herbert Hoover, talking from Washington, D. C., over the radio offered congratulations to Mr. Budd and paid tribute to the skill and co-ordination of those engaged in building the tunnel. W. W. Atterbury, president of the Pennsylvania Railroad, spoke from Baltimore and J. B. Campbell, chairman of the Interstate Commerce Commission, talked from Washington, D. C., as part of the dedication ceremonies.

The tunnel, located between Berne and Scenic, Wash., cuts out sixteen miles of winding mountain grades, most of which was covered with snow-sheds, including one 2¼-mile tunnel. This abandoned line replaced in 1900 the original line across the Cascade Range containing several switch-backs, which was located by John F. Stevens. Mr. Stevens was present at the dedication of the new tunnel.

San Francisco Water Bond Offer Brings No Bids

The recent offering of $41,000,000 of bonds, sale of which was authorized last year by San Francisco voters for purchasing properties of Spring Valley Water Company, brought no bids on Jan. 14 and city officials are now considering ways of making the issue attractive.

Reasons given for lack of bids are the large size of the issue that legal provisions require to be sold at par or above with interest at only 4.5 per cent. Under these terms and with the bond market in its present condition the issue is not considered attractive to banking syndicates. To permit sale below par would require amending the city charter and to raise the interest rate would require a special election.

Present prospects are that instead of being able to transfer control of water properties on Feb. 1, as scheduled, this may be delayed until May 1 as the bond sale must be effected before transfer can be made.

Brief News

A 500 TON STEEL CAISSON, 163x58 ft. in plan and 25 ft. high, has been launched by the Dravo Contracting Company at Wilmington, Del. The caisson will be towed to Philadelphia, where it will be used in the construction of a six-track bridge over the Schuylkill River at Market St. for the Pennsylvania Railroad.

THE NEW 1,200-FT. Yonge Boulevard viaduct across Hogg's Hollow in the city of Toronto has just been opened to traffic. The viaduct, built at a cost of $1,000,000, will carry the main highway traffic from southern Ontario to the north.

THE FIFTH ANNUAL ROAD SCHOOL of Syracuse University will be held from Jan. 22 to Feb. 1, inclusive. William M. Acheson, chief of the division of engineering of the State Department of Public Works, will be one of the speakers. Engineers from the State Highway Department, Portland Cement Association, National Paving Brick Association and the State Department of Public Works will be heard during the course.

THE ANNUAL ROAD SCHOOL at Purdue University, Lafayette, Ind., will be held Jan. 21-25, 1929.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Flood Control Hearings Asked—Columbia Basin Project Pushed

A JOINT resolution and an amendment to the flood control act have been introduced in each house of Congress to provide a basis for the flood control hearings. The principal purpose of these hearings is to question the Chief of Engineers at length as to his interpretation of the flood control act, under which damages are denied and as to the soundness of the fuse-plug type of control at the heads of the floodways. It is not anticipated that the act itself can be amended during the short session. For that reason the joint resolution presented in the Senate by Mr. Ransdell, of Louisiana, and in the House by Mr. Wilson, also of that state, attempts to reach the compensation question without amending the act itself.

The amendment was offered by Representative Reid, or Illinois, chairman of the flood control committee of the House. He proposes a new section to the act which is to read as follows:

"In the execution of the project herein adopted for the flood control of the Mississippi River in its alluvial valley and for its improvement from the Head of Passes to Cape Girardeau, Mo., the Chief of Engineers and the Mississippi River Commission are hereby authorized and directed to so construct spillways, floodways, diversion channels, storage basins, and reservoirs, that the flood waters of the Mississippi River shall be confined, controlled, regulated, and carried safely through such flood control works from Cape Girardeau, Mo., to the Gulf of Mexico."

Columbia Basin Irrigation

The Columbia Basin Reclamation Project recently given a favorable report by the House Irrigation Committee, has been given a place on the legislative calendar that will bring it before the House for consideration on Jan. 21. The bill was reported to the House with a reservation designed to protect the rights of Idaho and Montana and with an amendment stressing the economic phase of the undertaking. With these amendments, the measure is practically the same as the one that passed the Senate on Dec. 10.

Under the terms of the bill, as submitted to the House, the Secretary of the Interior is authorized to make a survey of the project and to report to Congress as to its feasibility with special reference as to whether a gravity or pumping system for obtaining the irrigation water is most practicable. The amendment relating to the economic phase of the development, directs the Secretary to investigate the legal problem of water rights, plans for the settlement and cultivation of the land, and whether or not the farmers residing on the land will be able to meet the construction costs.

The Columbia Basin project includes 1,800,000 acres of land lying east of the Columbia River in Washington. Water for irrigation can be obtained from the Pend Oreille River by gravity flow or from the Columbia River by means of pumping. As the bill merely provides for a survey and does not commit the Government to the project, it is not expected that there will be material opposition to its passage.

Engineering Societies

CALENDAR

Annual Meetings

AMERICAN WOOD PRESERVERS' ASSOCIATION, Chicago; annual convention, Louisville, Ky., Jan. 22-24.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; annual convention, Detroit, Mich., Feb. 12-14.

ENGINEERING INSTITUTE OF CANADA, Montreal, Que.; annual general and general professional meeting, Hamilton, Ont., Feb. 13-15.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; annual convention, Chicago, Ill., Feb. 18-22.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; annual convention, Chicago, March 5-7.

The American Society of Heating and Ventilating Engineers will hold its 35th annual meeting at the Edgewater Beach Hotel, Chicago, Ill., Jan. 28-31.

The Society of Engineers, San Francisco, Cal., at its annual meeting on Jan. 8 elected the following officers for the year 1929: Glenn B. Ashcroft, president; Edwin L. Driggs, vice-president; William G. Rawles, treasurer; Albert J. Capron, secretary; Donald E. Prenvielle and H. T. Sutcliffe, directors.

The Association of Professional Engineers of the Province of Ontario has elected the following officers: President, E. T. Sterne, Brantford; vice-president, George R. Mickle, Toronto.

Personal Notes

C. Neil Bass, former state highway commissioner of Tennessee, has been elected city manager of Knoxville.

H. L. Thackwell, formerly practicing civil engineering in Denver, has opened offices at Jacksonville, Tex., as a consulting engineer.

Frank F. Rogers, state highway commissioner of Michigan since 1913 and a member of the state highway department since its inception in 1905, has resigned. He is 70 years old. Grover C. Dillman, for the past 6½ years deputy of the department, has been appointed to succeed Mr. Rogers. Mr. Dillman has been connected with the department since his graduation from Michigan State College in 1913.

W. W. Mack has been elected chief engineer of the State Highway Department of Delaware. Mr. Mack has been secretary of the department and has served in other capacities. He is at present treasurer of the American Association of State Highway Officials. Allen Craig has been elected secretary of the department.

J. G. Schaeffer, formerly engineer of sewers in the city engineer's department, Regina, Sask., has joined the engineering staff of Underwood & McLellan, consulting engineers and land surveyors, Saskatoon, Sask.

Obituary

Willis Chipman, civil engineer, of Toronto, died on Jan. 3 in his 74th year. He was born in Elgin, Ont., and graduated from McGill University in 1876. For some years he was engaged in government survey work in the western provinces and northern Ontario. In 1899 he opened an office in Toronto, specializing in water and sewage-works, and rendered important service in perfecting the water supply of Toronto.

William Goodwill Button, construction engineer of the Philadelphia Bureau of Building Inspection, died on Jan. 6 as the result of an automobile accident. Mr. Button, who was graduated from the University of Pennsylvania in 1876, was appointed building inspector in 1894 and was promoted to construction engineer in 1907.

William Kind Eldridge, member of the firm of Eldridge & Fox, building contractors of Indianapolis, and the first graduate of the civil engineering school of Purdue University, died Dec. 30 in Indianapolis. From 1877 to 1894 he was interested in railroad construction, and from 1894 to 1901 served as city engineer of Lafayette, Ind. Mr. Eldridge was supervising architect for the E. G. Spink Company of Indianapolis for fifteen years before forming him own company.

John Gaffy, of Denver, who had been in the contracting business in that city for many years, dropped dead in his office on Jan. 3. Born in Wisconsin in 1862, Mr. Gaffy went to Denver in 1890, and with John A. Keefe as partner, erected many of Denver's major buildings in the early days.

Patrick Welch, pioneer western railroad builder, died at Coronado, Cal., recently. He was born in New York in 1859 and in the early eighties went to Montana on railroad construction with Larson, Keefe & Kirkendall. In 1896 he became associated with Larson, Welch & Stewart in Spokane, engaged in extending the Great Northern. Later the firm became Larson, Foley Bros., Stewart & Welch, doing much construction work on the Grand Trunk in western Canada. As Foley Bros., Welch & Stewart, the company did other railroad construction in Canada. The firm subsequently became Stewart & Welch and was associated with Porter Bros. in railroad construction in western United States and Canada.

Construction Equipment and Materials

No Accidents in Eighteen Cement Mills During 1928

Accident prevention work in cement mills has been unusually effective, according to the Portland Cement Association, which states that eighteen mills owned by twelve different companies operated in the United States and Canada throughout 1928 without a single lost-time accident. Each of these plants will receive the association's sculptored concrete trophy awarded annually to cement mills operating the entire calendar year free from mishap. In 1927 ten plants won trophies. Of the 150 competing mills three have received the trophy for two consecutive years.

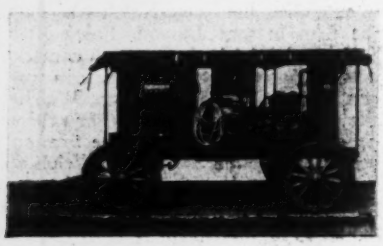
Film Shows Use of Arc Welding in Manufacturing

A new educational motion picture portraying the advantages and possibilities of arc welding and entitled "Modern Manufacturing With a Stable-Arc Welder" has recently been released by the Lincoln Electric Company, Cleveland, Ohio. The new film compares the physical characteristics and cost of cast-iron and rolled steel, also of cast-iron, riveted steel and arc-welded steel construction. The motion picture is contained in three reels of standard-size film. It is also available in 16-mm. film size. It is offered gratis on application to the Lincoln Electric Company.

New Developments

Arc Welder and Air Compressor on One Chassis

The new machine shown in the accompanying illustration has been added to the line of special electric welding equipment manufactured by the Wilson Welder & Metals Company, Inc., Hoboken, N. J. It is a gasoline engine-driven electric arc welder, combined with an Ingersoll-Rand air compressor. Its steel frame is carried by four lengthwise elliptical springs and is mounted on a four-wheel rubber-tired trailer. The company points out that the machine is especially advantageous for those companies and contractors that do welding outside of their own shops and need facilities for operating riveting and chipping machines and grinders as well as the welding torches.



Heavy-Duty Grader and Scarifier Incorporates New Features

With a weight of 12,000 lb. and special frame design to secure rigidity and ease of operation, the new Model 14 grader of the J. D. Adams Company, Indianapolis, Ind., is capable of working behind the largest and most powerful tractors. Tubular cross-members placed between the two frame beams supplement the usual cross-bracing giving added insurance against frame twisting. In addition, a ball-and-socket joint in the front truck, replacing the usual fifth wheel, gives freedom of motion to the front truck without twisting the frame. Particular attention has been given to ease of adjustment, which is provided by worm gears, spur gears and a special blade lift. The latter employs continuous motion hand wheels and reduction gears in the lifting mechanism. It is said that the 8:1 gear reduction gives the operator as much leverage on his 16-in. wheels as could be obtained on 128-in. hand wheels of the ordinary type. All gears are placed in oiltight housings. Alemite lubrication and Hyatt roller bearings are standard equipment.

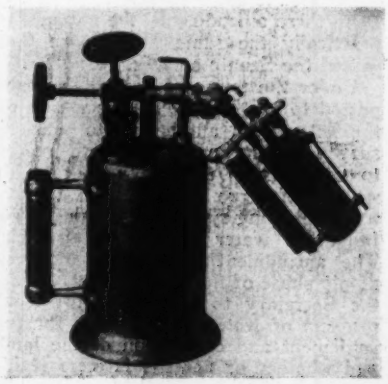
Shear, Punch and Coper Offered as a Combination Machine

A small combination shear, punch and coper claimed to embody all the strong points of the larger cast-steel frame combination machines has been developed by Joseph T. Ryerson & Son, Inc., Chicago. The punch has a deep throat and is capable of handling most varieties of structural shapes within its capacity. The shearing end of the machine is constructed so that a single slide handles the shearing of angles, bar cutting, plate shearing and coping. The angle shear attachment handles both inside and outside miter cutting as well as straight shearing. The blades in this unit are made in sections for cheap and easy replacement. Bar-cutting blades are located directly below the angle shear blades, and handle both round and square sections. Below the bar cutter are located the plate-shearing blades, which will handle plates of any width or length and up to ⅞-in. thickness. The coping device is built at the shear end of the machine and is extended out from the frame and located at a convenient height for operation. It is regularly furnished in the V-notch type, but the square notching feature can be provided. The clutches are of the two-jaw type, giving the operator a chance to engage the clutch every half-revolution of the clutch gear. The machine is placed directly on the floor, eliminating the necessity of building up a concrete pier in order to bring the machine to a proper working height. This design is intended to make the machine portable.

Heating in Difficult Locations Aided by Swivel Head Torch

A new design of hand torch claimed to do all heating work much faster and the work in difficult locations much more readily and easily has been developed by the G. H. Williams Company, Erie, Pa. The torch is so designed that the intense heat is concentrated on the spot to be worked. The swivel head of the torch enables the mechanic to direct the full force of the 14-in. flame on the work from any position. It gives him the advantage of a full 180 deg. working range and makes unnecessary the removal of a part of the machine or structure hard to get at.

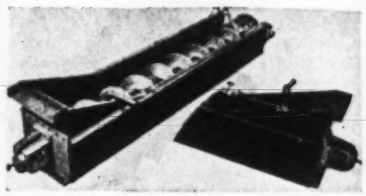
It is claimed that in less than two minutes after lighting the preheater of the "Universal" torch the nozzle is hot enough to cut off the preheater and



start using the pressure flame. The generator, which is a ¼-in. special alloy bronze pipe coil, insures a steady flow of correctly aerated gas to the needle valve. The nozzle itself has three oxygen intakes, insuring correct mixture of gas and air to give the best heating results. The reservoir is a heavy seamless steel tubing with the head and base shrunk in, riveted and brazed. It is said that the patented swivel head is so constructed that the valve seats accurately at all times and is held firmly in place by a heavy steel spring. The torch is made in ½- and 1-gal. sizes.

Rewasher Assures Cleaner Sand

Sand containing so much dirt and fine material that satisfactory results cannot be attained with the usual type of washer apparatus can be made suitable for use by means of a new screw rewasher designed by the Smith Engineering Works, Milwaukee, Wis. This consists of an inclined metal trough in which is fitted a cast-steel



screw which is rotated by means of bevel gears at the upper end. The screw is made in sections threaded upon a shaft of cold-rolled steel provided with a roller bearing to take the end thrust. The entire unit is mounted on an incline, the screw serving to agitate and wash the sand thoroughly and withdraw it from the water. The machine may also be used to wash rock by increasing the clearance between the trough and the screw.

Business Notes

CONWAY CLUTCH COMPANY, Cincinnati, Ohio, announces the appointment of the Watson-Flagg Engineering Company, of Paterson, N. J., as its distributor in New Jersey and the Brewster-Nicholas Company, of Cleveland, as distributor in Detroit, Cleveland, northern Ohio and Michigan.

AMERICAN CEMENT MACHINE COMPANY, Keokuk, Iowa, announces the purchase of the Inland Construction Equipment Corporation, of that city manufacturer of Mandt automatic dump bodies. The American Cement Machine Company also announces a new direct-to-consumer selling policy on all its Boss mixers, pavers and hoists.

SHEFFIELD STEEL CORPORATION, Kansas City, Mo., announces that J. J. Hasburgh has been appointed manager of sales, reinforcing division. Mr. Hasburgh has been with the company for the last nine years as a special salesman on reinforcing. Lester G. Schraub, who has just been appointed manager of sales, wire division, came from the Keystone Wire & Nail Company, of Peoria, Ill., with which he has been connected for the last seventeen years, part of the time as assistant sales manager.

SHEPARD-NILES CRANE & HOIST CORPORATION is the name of the new company formed by the combination of the Shepard Electric Crane & Hoist Company and the Niles Crane Corporation. The combination is said to place the company in a position to provide a line of standard and special traveling cranes and electric hoists more comprehensive in its range of sizes and types than any heretofore available. The Shepard plant at Montour Falls, N. Y., and the Niles plant at Philadelphia, Pa., will be continued in operation as previously. The main office will be at Montour Falls. The officers of the new corporation will be: Edward A. Deeds, chairman of the board; S. G. H. Turner, chairman of the executive committee; Frank A. Hatch, president; Sydney Buckley, first vice-president; James A. Shepard, vice-president; Robert T. Turner, vice-president. To the board of directors also will be added from the Niles-Bement-Pond Company, Leonard S. Horner, president, and Charles K. Seymour, vice-president. The three divisions of the new corporation will operate as the Shepard division, the Niles division and the Sprague division.

PITTSBURGH-DES MOINES STEEL COMPANY, Pittsburgh, Pa., announces that J. E. O'Leary, who has been in charge of sales at the New York office since its opening in 1914, has been promoted to general sales manager of the company and will assume his new duties at the home office in Pittsburgh about Feb. 1. H. W. Ford will succeed Mr. O'Leary as manager of the New York office. G. A. Smith will direct the construction and erection activities of the company. W. E. R. Moore, formerly with the American Locomotive Company, will be export manager.

LINK-BELT COMPANY, Chicago, announces the appointment of the J. L. Latture Equipment Company, Portland, as its crane and shovel agent for the State of Oregon and eastern Washington. The company was established in 1919 and occupies a four-story concrete building at the present time.

SULLIVAN MACHINERY COMPANY, Chicago, announces that Arthur E. Blackwood has been elected president of the company, succeeding the late Frederick K. Copeland. Mr. Blackwood has been with Sullivan for the past 32 years, coming to the company shortly after graduating at Toronto University as a mechanical and electrical engineer. He later became manager of its Eastern sales department, with headquarters in New York, which office he held for 23 years. He was then elected a director and first vice-president in charge of finances, and moved to the company's head office in Chicago.

Manufacturers and Trade Associations

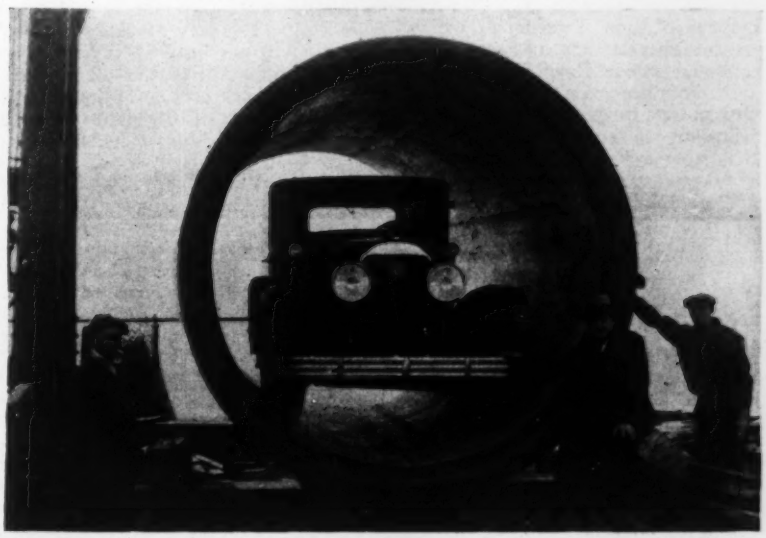
CALENDAR

Annual Meetings

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 21-24.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION, Washington, D. C.; annual meeting, Washington, D. C., Feb. 13-15.

CONCRETE PIPE FOR USE IN BUFFALO



Unusually large concrete pipe is being produced for the city of Buffalo, N. Y., by the George C. Bartram Company. The illustration shows a 20-ft. section with an inside diameter of 8½ ft. and a weight of 30.34 tons. Photograph furnished by the Great Lakes Portland Cement Corporation, Buffalo, N. Y.

The Business Side of Construction

High Credits Decrease Volume of Bond Offerings

Authorities are agreed that the credit situation and outlook call for close consideration. Interest rates on time loans secured by collateral have been higher during the last six months than they have during any other six month period, except in 1920. Reasons advanced are the attempt of the Federal Reserve banks to curb speculation, the exportation of gold, and in some measure, the increase in bank loans.

A result of these high money rates is a slowing down in the volume of bond offerings. This month's offerings, at the present rate, will be only half those of January, 1927. It is estimated that $500,000,000 of new bond issues are being held back pending easier credits.

The table lists several recent public offerings.

RECENT PUBLIC BOND OFFERINGS

Municipal	Amount	Interest	Yield
Cincinnati, O., school	$690,000	4½	4.15
Dortland, N. Y., school	575,000	4½	4.25
Eastchester, N. Y., school	800,000	4½	4.40@4.20
Fremont, O., water	50,000	4½	4½
Greensboro, N. C.	950,000	4½	4.45@4.50
	1,000,000	5	
Hillside, N. J.	1,000,000	5½	4.80
Kershaw Co., S. C., highway	800,000	5	4.60
Linden, N. J.	464,000	4½	4.50
Los Angeles, Calif.	600,000	5½	5.75@5.50
Massena, N. Y., water	225,000	4½	4.35@4.30
Minneapolis, Minn.	880,978	4½	4.25@4.05
State of Mississippi	2,374,500	4½	4.30
New Orleans, La., paving	1,744,000	4½	4½
Peoria, Ill., sewer	2,415,000	4½	4.50@4.25
Richland, Lexington and Saluda Counties, S. C., highway	700,000	4½	4.80@4.50
St. Paul, Minn.	1,000,000	4½	4.50@4.05

Land Cable for Buenos Aires

Compania Union Telefonica, which at present operates an overhead telephone line between Buenos Aires and Rosaria, has been authorized by the chief executive, through the Minister of the Interior, to construct an underground cable system between the two cities to replace the present overhead line. The total cost of the project, which is to be finished within two years, is placed at $2,150,000.

Large Unfilled Lumber Orders

West Coast Lumbermen's Association reports unfilled orders at the end of the year to the amount of 192,166,124 ft., b.m. Of this, 93 per cent is at 88 mills in Washington and Oregon, and the remainder at 15 mills in British Columbia. Operating schedules reported by 180 West Coast mills indicate a winter output 500,000,000 ft. below capacity. This reduction includes the usual decrease due to holidays and midwinter shut-downs for overhauling and repairs.

E. N.-R. Index Numbers

Cost		Volume	
Jan. 1, 1929	**209.40**	**December, 1928**	**244**
Dec. 1, 1928	210.16	November, 1928	251
Jan. 1, 1928	203.90	December, 1927	319
Average, 1928	206.78	Average, 1928	287
Average, 1927	206.24	Average, 1927	263
1913	100.00	1913	100

Tariff On Building Materials Urged at Federal Hearing

Duties on construction materials are being discussed by representatives of the trades concerned in open hearings before the Ways and Means Committee of Congress. A tariff on brick was urged Jan. 10 by Frank Kasten of Chicago representing the Brick and Clay Workers of America. Paradoxically it developed that the chief source of competition is in the cheapest grade of bricks which are not protected, it being thought impossible that they could be shipped from abroad at a profit. More than 85,000,000 common brick have been coming into New York every year for the past three years, Mr. Kasten said. Belgian bricks can be delivered in New York at a cost as low as $7 per thousand according to the figures quoted. They are carried as ballast at a nominal charge by a line subsidized by the Belgian government. Thus ten per cent of the bricks required in New York's building program are produced in foreign countries. Manufacturers on the Hudson have had to curtail production and decrease wages. As a protective measure, a specific duty of $4 per thousand plus an ad valorem duty of 30 per cent based on American valuation was requested.

For face brick which is said to be threatened by increasing importations from Holland a duty of $10 per thousand plus 10 per cent ad valorem was recommended. On tiles, a duty of not less than 60 per cent ad valorem was asked for most of the items classed under this name. Importers, however, wished floor tiles from Welsh quarries now assessed at 30 per cent to come in free.

Several witnesses appeared on the subject of gypsum. There has been recent contention before the Bureau of Customs as to whether crushed gypsum is on the free list as crude gypsum, dutiable at 30 per cent ad valorem as a partly manufactured mineral, or at $1.40 per ton as ground gypsum. In the hearings Jan. 10 the producers asked for $3 per ton on crude, $3.50 on crushed, and $4.25 on calcined, contending that milling interests especially in New York State were being forced out of operation by Canadian mines possessing advantage of cheap mining and water transportation. Manufacturers of gypsum materials, however, advocated that such increases benefit a small territory at the expense of much more extended interest. They requested that gypsum be placed on the free list.

Further requests for change in tariff on steel products and also a 25 per cent ad valorem duty on shingles and cedar lumber (now on the free list) were received by the Committee.

According to the cedar tariff committee, this industry is particularly hard hit in Washington, Oregon and Idaho. The removal of the shingle tariff in 1913 has caused an annual loss, it is claimed, of 16 per cent to the domestic manufacturers of this product.

New Foreign Railway Projects

The route which will provide railway connection between Burma and Siam is a direct line from Mergui in Southern Burma to Prachub Kirikan, a small station on the other side of the frontier on the seacoast. In the latter town there is a large air base. The whole of the country to be traversed by the railway is wild and practically unexplored, but it is said to be rich in tin. Preliminary surveys have been made.

It was reported on July 20, 1928, that the Madras-Delhi direct line, under construction since February, 1925, was established with the completion of the last section from Kazipet to Peddawali, a distance of 146 mi., at a cost of $80,000,000.

Electrification is going forward in Morocco. The Morocco Railway Company has about 130 mi. of track electrified. The entire system in operation by electricity and steam comprises 265 miles, with projected extensions of nearly the same length.

The Telkwa-Kitimate Railway Company will make application to the British Columbia provincial legislature for a charter to construct a railway and operate a freight and passenger service, together with telegraph, telephone and wireless telephone systems, between Telkwa, situated 230 mi. west of Prince George, and Pacific, 120 mi. east of Prince Rupert, on the line of the Canadian National Railway.

RESIDENTIAL BUILDING contracts awarded Jan. 5-Jan. 11 numbered 1,820 covering 2,560 buildngs, valued at $31,861,000. The average cost per square foot is $4.80, compared with $4.90 for the whole of 1928.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended Jan. 15, with some comparisons, total as follows:

(In Thousands of Dollars)

	Jan. 15, 1929	Jan. 8, 1929	Jan. 17 1928
Building:			
Industrial	$53,444	$12,898	$10,740
Commercial	37,813	29,001	20,916
Streets and roads	6,271	7,806	4,737
Other construction	64,154	23,934	9,618
Total	$161,682	$73,639	$46,011
Total, all classes, Jan. 1 to Jan. 15:			
1929			$279,555
1928			170,633